ORGANIZATION OF SILVICULTURAL RESEARCH IN INDIA

BY JAGDAMBA PRASAD, DY. CONSERVATOR OF FORESTER.

INDIA has a Silviculturist at Dehra Dun and each province has a Silviculturist. The latter are more favourably situated, as they have the forest area of the province concerned at their back and call to initiate research. The Central Silviculturist has no such facilities. A nursery and a few small plantations are all that he can call his own field of operation. There is of course little "bread and butter" work that he can put in and therefore the greatest care has to be taken to ensure that the invisible effects of what he does are of paramount importance.

This is provided for by the programme of work, which is based solely on the recommendations of the silvicultural conferences, that have an all-India representative character.

But there is a personal side that needs examination more closely. The net effect of the activities of the Central Silviculturist is that of a consulting and co-ordinating agency, and a source of assistance in field work, when needed by the provinces, providing steady and often unobtrusive small improvements in technique. This has naturally

a tendency to degenerate into a mere routine, lacking inspiration or enthusiasm.

Silvicultural research must be objectively directed to the basic principles of forestry. Successful work must maintain the organisation in a very much "alive and kicking" condition, with all the Silviculturists in the provinces and the one at the centre working in teams. To a certain extent the tours of the Central Silviculturist and of the statistical parties that are at times invited to help provinces in times of need, provide something in the way that is needed. But in a way they are on a different plan altogether. Their purpose is for meeting particular needs of the project, on the one hand.

On the other hand, the silvicultural conferences alluded to above meet once in five years, while admittedly there may be constantly changing priorities, because of the increasing uses of wood and wood products.

The first essential step is to secure an intimate relationship with the forest departments of the provinces so that a copious flow of information is stimulated in either direction. For outstanding progress, therefore, the holding of say three regional committees, of ten days duration each, annually, at Simla (for East Punjab and the United Provinces), Ranchi (for Assam, West Bengal, Orissa and Bihar) and Nagpur (for Bombay, Madras and Central Provinces), on which, besides the central and provincial Silviculturists, working plan and utilization sides should also be represented, will be found hard to improve upon.

At these meetings the relative values of proposed investigations could be settled, and the necessary co-operation for the investigations arranged. A feature should be the presentation of authoritative reports by each representative, besides intimate contacts in the sub-committee stages, informal meetings and excursions which the local officers may be able to arrange at these places.

The tone and morale of silvicultural work will improve and each worker will gain a new zest. For the publication of the work of these meetings no better channel can be thought of than the pages of the INDIAN FORESTER, which will be only too glad to have an additional reliable source for copy.

These meetings will also help in reducing the time interval between the findings of research and their adoption on the district scale, the finalization of seed indents and other matters.

MEASUREMENT OF LIGHT IN FOREST STANDS

By Sami Ahmad

G/11313/Gn., G/132/Gn.—Previous work relating to the measurement of light intensity in plantations of Pinus banksiana and the measurement of light by different methods is reviewed.

[This paper sums up two terms work done by the author at the University of Oxford in the year 1946. Most of the work had to be preliminary in nature, particularly in regard to checking up on previous experiments in measuring light intensity in Forest stands. As the writer had to leave Oxford before he could verify in the field his own conclusions, the work could not be completed. Since his return to India facilities for further work have not been available so far, and hence he regrets the absence of any readings in the present paper.]

Originally the intention of the author was to study changes in light intensities caused by thinnings, and their effect on the growth of the particular species concerned attention being confined to the visible portion of the electromagnetic radiation spectrum. It soon became evident, however, that very little previous work had been done on the subject ; and whatever little had been done was unreliable due to technical faults. Attention was involuntarily drawn to the fact that before such a study could be attempted, earlier methods of measuring light must be examined in detail, and improvements where necessary effected. The subject, therefore, was changed to the one given above.

ADAMS (1) was the first to study variations due to thinning ; but he studied only the other microclimatic factors ; and paid no attention to light at all. The only study of light in this connection was made by HANSEN (9) in plantations of *Pinus banksiana* He used black and white atmometer bulbs ; and compared the rates of evaporation from each, thus obtaining a rough measurement of the light intensity. Later he used a photoronic cell for the same purpose. Both his methods are discussed later. His conclusion was that growth is proportional to the amount of light admitted—the best growth being in the most heavily thinned plot. No other work on this subject appears to have been done.

Quite a large amount of work has been done on the measurement of light alone ; and SHIRLEY (14) gives an admirable summary of the measurement of light and its role as an ecological factor. The methods employed so far for the measurement of light can be sub-divided into the following main groups based on the apparatus used :—

(1) Black and white bulb thermometers.

(2) Black and white atmometer bulbs.

(3) Potentiometer methods

(4) Methods using photoronic and photo-electric cells.

(5) Photographic methods.

Method 1 was used by HALL (8). He mounted 2 thermometers on a board, and coated the bulb of one with lamp black; and exposed them to sunlight in a forest. Owing to the superior absorption of a black body, the blackened thermometer generally indicated a higher temperature; and the difference in the temperature between the two thermometers was taken as a measure of the light intensity. In short the heating effect of sunlight was used as an indicator. It must however be pointed out that in the solar spectrum, the heating effect of the visible portion is small compared with the infra-red. Several other factors also serve to make a measurement of this type extremely unreliable. First and foremost is the presence of water vapour in the atmosphere, which absorbs the infra-red waves very strongly but has comparatively little effect on the visible radiation. Thus, on a cloudy day, the dimunition of light, shown by any method measuring it by its heating effect, will be much greater than it actually is. Again daily readings will be affected by the moisture content of the atmosphere; and days on which the light may be of equal intensity, would not give identical readings with these methods, if the aqueous tension alters. Lastly the method is not sensitive enough, appreciable changes in light intensity not showing up very well.

The same objections apply to method 2 which was used by HANSEN (9) in his investigations on *Pinus banksiana*; and thus sender his conclusions unreliable. This method consists in comparing the rates of evaporation of water from two atmometer bulbs one of which is blackened. Water evaporates more freely in sunlight from the blackened bulb; and the stronger the sunlight, the greater the difference between the two bulbs. Thus this method also depends on the heating affect of sunlight and suffers from the same drawbacks.

Method 3 was used by GAST, (7) SHIRLEY, (13) BURNS, (5, 6) PEARSALL (11) WALLACE, (18, 19) WALLARD & SMITH (20) and a host of others. The method essentially consists of measuring the difference in potential between the two junctions of a thermocouple, one of which is maintained at a constant temperature, and the other exposed to sunlight. The best of the lot is the one described by WALLACE (18) in which he uses a recording potentiometer. WILLARD AND SMITH (20) give details of a method for calibrating it to obtain absolute values. This method again depends on the heating effect of sunlight; and has drawbacks similar to 1 and 2 above. It is, however, considerably more sensitive.

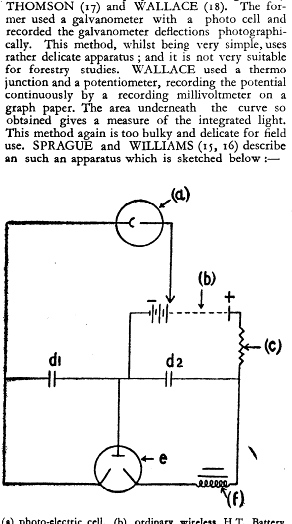
Method 4 has been used by several workers, varying from a simple photographic photo-electric exposure meter to photo cells used with galvanometers or milliammeters. The method consists in measuring the current produced by a photo cell under different stands. Since this current is proportional to the intensity of the light falling on the cell, a direct measurement is thus obtained. Various kinds of apparatus have been described by ATKINS (2, 3), HOWLETT (10), THOMSON (17), and BACON (4). This method of measurement is particularly desirable because the relationship between current and light intensity is linear as also the response of a photo-cell is very similar to that of the eye as far as different portions of the spectrum are concerned. The effect of infra-red rays is also small.

Both methods 3 and 4, however, suffer from some common drawbacks. First of all, the mounting of the instrument affects the observations. Thus if the instrument is mounted horizontally, it will respond less to morning and afternoon light than to light in the middle of the day, and *vice versa* if mounted vertically. In order to make the observations independent of the angle of incidence it is necessary to mount the instrument horizontally inside an opalescent glass sphere, which integrates all the light falling on it; and transmits it as a whole to the measuring instrument [WALLACE (19)]. Secondly the action of infra-red rays, the photo-cell being affected much less than the thermo junctions, however. In the case of the photo-cell heating affects the characteristic of the cell; and on a very warm day readings will not be strictly comparable with those on a cool day. The temperature co-efficient is, however, small. This can be avoided by using a water-filter which absorbs all the infra-red rays. A water-filter may be difficult to use with an integrating sphere, but this difficulty can be overcome by mounting the filter on the face of the photo-cell or thermo junction inside the sphere. The use of water-filter with a thermo junction presents another difficulty. In order to measure the small amount of energy due to the visible spectrum only, a vacuum-thermo junction in combination with a Crompton potentiometer and a Moll galvanometer will have to be used. This makes the apparatus too bulky and delicate for use in the field.

Lastly all these methods measure the light intensity at any particular instant; and except under artificial illumination, any 2 observations of this nature will not be comparable. Also a point observation of this nature is of very little value in forestry practice, where measurements have frequently to be comparable over a period of years. Attempts were made to overcome this difficulty by expressing the light inside a stand as a percentage of the light under the open sky. But even this was found not to be a constant and varied at different times of the day

the observation inside the stand being affected by the amount of light intercepted by the canopy which in turn varied with the solar zenith distance. Obviously, if a measure could be obtained of the total amount of light received by a point inside the stand during the hours of daylight, and this measure expressed as a percentage of the total light under the sky, the figure so obtained would be a constant and independent of weather conditions. Any variations in this figure will reflect changes in the canopy density only and *not* hourly or daily variations of sunlight. What is therefore required is an instrument that will integrate light over the whole period of the day.

Methods for this purpose have been given by THOMSON (17) and WALLACE (18). The former used a galvanometer with a photo cell and recorded the galvanometer deflections photographically. This method, whilst being very simple, uses rather delicate apparatus; and it is not very suitable for forestry studies. WALLACE used a thermo junction and a potentiometer, recording the potential continuously by a recording millivoltmeter on a graph paper. The area underneath the curve so obtained gives a measure of the integrated light. This method again is too bulky and delicate for field use. SPRAGUE and WILLIAMS (15, 16) describe an such an apparatus which is sketched below :—



(a) photo-electric cell. (b) ordinary wireless H.T. Battery (c) 250,000 ohm resistance. (d 1, d 2) condensers. (e) Double anode cold cathode relay tube—Type Western Electric 313C. (f) Magnetic relay actuating recorder.

The action of the circuit is as follows :—

Light falling on the photo-cell causes a current to flow which charges up the condenser d2. When d2 charges up sufficiently to break down the resistance of the relay tube, it discharges through it causing the condenser d1 to discharge simultaneously, thus actuating the recording mechanism through the relay f. If the total number of discharges thus recorded during the hours of daylight inside a stand is expressed as a percentage of a similar figure obtained under the open sky, this should be constant, unless the canopy density is altered. SPRAGUE and WILLIAMS did not conduct any measurements with it and no results are given.

Attempts were made to set up this apparatus ; and conduct measurements using all the precautions listed before. A cold cathode relay tube could not be obtained ; and as a substitute a G.E.C. hot cathode thirotron was used. The circuit was slightly modified by connecting up condenser d2 to the grid of the thirotron, and also putting a negative bias on the grid, to prevent a continuous discharge of the condenser d1. This circuit did not work due to self oscillations being set up, which completely swamped the current variations from the photo-cell caused by different light intensities. Also as the thirotron did not have a sharp cut off voltage ; even after quenching the oscillations, satisfactory performance was not obtained. The whole experiment had perforce to be abandoned.

Method 5 has not been described so far. No previous work by this method has been done ; and it is possible to use it to give integrated measurements. The best type of camera to use is a fixed focus low aperture type using 35 mm film. Two black lines about a foot apart should be ruled on a matt white screen of dimensions 2′ × 2′. One such screen is to be set up inside the stand and one under the open sky. Two cameras preferably on tripods should be set up 4′-6′ away from the screen, and coupled electrically so that both can be exposed simultaneously; half hourly exposures should be made, using a fixed stop and fixed exposure throughout the whole day. At the end of the day both films should be developed at a fixed temperature for an equal length of time. If these films are now passed through a microphotometer, a curve will be obtained for each film; and the area under each curve will be a measure of the integrated light intensity for the whole day, for the two sets of conditions. The area underneath the curve obtained from the stand can be expressed as a percentage of the area of the open sky curve, and should be a constant for the same canopy density. This method has not been tried out practically.

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NOTE ON THE SELECTION OF SILVICULTURAL TECHNIQUES

BY SHRI JAGDAMBA PRASAD

SUMMARY.

/114/R1.—

The scope of the paper is defined. The paper seeks to emphasise how our conditions make it difficult apply so-called silvicultural systems, evolved for pure forests, where natural regeneration is not a serious roblem, and the contribution to silvicultural techniques that Indian silviculture offers.

Intensive silviculture should replace extensive technique. Resource survey and the application of land se principles should receive the highest emphasis. Published illustrated accounts of standardized silvicultural ystems and forest types are a necessity. A permanent BUREAU should be made responsible for the dis-mination of details and encouraging enquiries and discussion.

Centralise preparation of working plans, or establish experimental forests, under the direct operation ommand of the silviculturist. Provide a well equipped soil and biochemic laboratory to work as an integrated nit of silvicultural research.

Appoint an ad hoc commission to lay down a code for research in thinning. Put research on tree reeding and forest genetics on the map. Plan for making the fullest use of results of silvicultural research.

ntroduction.

The scope of this paper has been defined to nclude (I) principles governing the selection of lvicultural systems, suitable to (i) given forest onditions, and (ii) management objectives, and ii) the establishment of suitable forest research rogrammes, including provision for statistical nalysis. As this is an experience paper it is based n actual experience in the application of the relavant echniques, at the same time relating the particular xperience to the general topic.

The paper seeks to bring out and emphasise) how our conditions (mixed forests, tropical onditions, biotic factors, etc) make it difficult to pply so-called silivicultural systems, evolved for ure forests, where natural regeneration is not a rious problem, and (2) our contributions to silvicul-ral techniques (Taungya system, stump planting, ontrolled use of fire, etc.)

ndia and its forests--

India lies entirely to the north of the equator, e southern most point, Cape Comorin, being in titude 8° N. The tropic of cancer cuts the country oughly into two halves, but although a half of the ountry lies in the temperate zone, India has a tropi-al climate because of its being cut off from the ontinental mass of Asia by the Himalayan girdle. ndia is a vast country, but it is the extreme variation f the types of natural vegetation found that are ermane to our subject here. Up at the extreme orth we have Alpine vegetation and Alpine forests. n the very highest mountains, of course, say above 8000 feet, there is always snow. Below we have egetation, but there is a distinction between the estern and the eastern part of the Himalayan girdle. *Zingiberaceae*, *Orchideae*, *Aroideae* and *Begoniae* are very characteristic of the vegetation of the eastern Himalayas, but out of 25 Indian species of *Artemisia* only two occur in the eastern-though abundant in the western-Himalayas. *Cedrus deodara* does not extend east of the west of Nepal. Between 6 and 8 thousand feet is the chief zone of the Deodar and the blue pine, as also of the cypress. Above 7 thousand feet *Quercus dilatata* generally supercedes *Quercus incana*. *Buxus sempervirens* occurs in damp valleys, especially on limestone. Between 8 and 11 thousand feet we have *Picea morinda*, *Abies pindrow* from 7 to 9 thousand feet and *Abies webbiana* from 10 to 14 thousand feet. There is also a third oak, *Quercus somecrapifolia*. On ascending to 12 thousand feet we have *Betula utilis*, and above it the juniper. The higher forests of the eastern region contain the conifers, *Abies webbiana*, *spruce*, *Larix griffithii*, *Juniperus recurva* and *Tsuga brunnoniana*. Below the conifers are gregarious rohododendrons with birches, maples, etc. Oaks (*Quercus lamellosa* and *Q. glauca*) and chestnuts occupy a belt between 6 and 8 thousand feet.

Shorea robusta (Sal), follows the foot of the Himalayas, extending southward to the Godavari in the Circars and to the Central Provinces. The other features of the deciduous region are the *Xylia dolabriformis* forests of the Circars, from the Mahanadi to the Kistna extending in the Chanda district of the Central Provinces and into Hyderabad, and the region of teak, which commences where the sal leaves off and extends to the southward end, embracing the region of *Pterocarpus santalinus* on the hills of Cuddapah and North Arcot and the region of sandal, on the hill ranges of Bellary, Coimbatore and Salem and the northern slopes of the Nilghiris.

Where the rainfall is more than 80 inches we find forests where the trees are evergreen. The evergreen zone, in which the trees belong to the families *Anonaceae, Guttiferae, Dipterocarpaceae, Anacardiaceae, Myrtaceae, Rubiaceae, Lauraceae, and Euphorbiaceae*, comprises the west coast, the Carnatic and the sub or outer Himalayan tracts. Higher up especially in the hill ranges of the Nilghiris. Anamalis, Pulneys and Travancore mountains, these evrgreen forests merge into sholas, consisting of *Eugenia, Michelia, Ilex, Hydnocrapus, Elaeocarpus, Ternstromia, Gordonia, Symplocts Rhododendrons* and *laurels*, with an undergrowth of *Strobilanthes* and tree ferns, etc. In this region teak is the chief tree of export, followed by *Dalbergia latifolia*.

The riparian forests found in the midst of different regions are invariably distinct from the surrounding forests. *Dalbergia sissoo* and *Acacia arabica* make up these fringing forests, in the frost belts the latter being replaced by *Acacia catechu*.

The tidal forests are also a class by themselves. Along the sea face are the mangrove forests, consisting of *Rhizophora mucronata* and *Rhizophora conjugata, Ceriops roxburghiana, Kandelia rheedii, Bruguiera parviflora, Sonneratia apetala, S. acida, S. griffithii, Aegiceras majus* and *Carapa moluccensis*. Further inland the mangrove species become more subordinate, while *Sonneratia apetala* and *Avicennia officinalis* prevail.

Then we have the scrub forests and desert or semi-desert vegetation and grasslands.

The selection of the silvicultural technique becomes extremely hazardous and complicated with such a variation in the natural types of vegetation. Added to this is a factor which is not very much appreciated outside India and that is the great multiplicity of species in our enumerated types of forest regions, when the comparatively undeveloped state of demand for the timber confined management to cater for a single species out of the myriad found naturally in the forest.

India's contributions to silviculture.

The very first attempts at the introduction of silvicultural technique brought in the Brandis' method of 1856, castigated as almost a fraud on the selection system of Europe, but still of service in modern working where natural regeneration is not certain. The system of linear valuation surveys on which it is based and the classification of trees into diameter classes, to fix the annual yield are the domain of management or working plans, but nevertheless the last refuge, for tackling diffculties in the natural regeneration of the favoured species.

The classical contribution of Indian silviculture is the Taungya system. This system of regenerating the forests is a combination of the custom of shifting cultivation and tree plantations. Its Burmese name Taungya has come to be accepted in literature generally, and wherever foresters have gone to the far-flung parts of the world, with a previous experience of Indian silviculture, they have introduced the system, to the great benefit of world forestry. In its first conception labour for the work was provided by the unsophisticated populace, accustomed to the technique, but in centres of demand, the cultivators have even come forward to pay for the use of the land for raising field crops, and inclusive of the conditions that it is essential to impose for the success of the silviculture part of the technique. Originally employed for the regeneration of teak, it has been successively used for*Acacia catechu, Xylia dolabriformis, Terminalia tomentosa, Pterocarpus macrocarpus, Gmelina arborea, Alnus nepalensis Bucklandia populnea, Cryptomeria japonica, Shorea robusta, Bombax malabaricum, Ailanthus excelsa, Broussonetia papyrifera, Pinus longifolia, Morus alba, Dalbergia sisssoo* and other species suited to the localities concerned. For cultivation with the Indian plough, a spacing of some 20 feet between the lines of tree plants is usual. Experience has also shown that intimate mixtures of species by individual plants are highly undesirable for a full stocking.

Analogous to the Taungya is the Rab system, practised by cultivators in Bombay and the Deccan for rice. For the dry areas, where adequate reproduction by coppice is not forthcoming, the Rab has provided a valuable means of introducing a nucleus of the desired species by burning the debris after proper stacking and compacting to obtain a good burn and of raising tree species later by sowing or planting. The good burn reduces the growth of weeds that makes for a good initial start for the planted species.

The phenomenal development of the method of stocking, known as stump planting, in connection with teak, in South India, since the early twenties of the twentieth century, deserves mention, in connection with artificial regeneration work. It requires plants that are a year old, that are pruned to leave some 9 inches of root and $1\frac{1}{2}$ inches of shoot, before being planted out in crow-bar holes at site. The method is not capable of universal application, for instance in the case of *Shorea robusta*, though a leafy shoot is produced, there is no root formation and the plant dies down as soon as dry conditions set in. But

the usefulness of the method in large plantation areas, involving transport of planting stock in matchless.

The controlled use of fire, in *Pinus longifolia* forests for protection, and as a preliminary for providing a good seed bed for regeneration in *Pinus longifolia* and in *Shorea robusta* and teak forests, has led to the development of special techniques, as to when and for how long the burning is to be undertaken to achieve the desired results.

The coppice with reserves is a modification of the simple coppice for poor quality teak forests of the central Indian region and the dry forests of miscellaneous species, where teak is found in varying proportions, providing for the retention of a number of well grown poles of the miscellaneous species in an otherwise clear-felled area, to form part of the future crop. Besides, good groups of teak poles are also retained. The system caters for the varying nature of the vegetation in this region.

Intensive silviculture.

The pivotal point in the selection of the silvicultural technique is the elimination of " preventable and costly waste, both of renewable and nonrenewable resources ", in the new order of the day and *ipso facto* expensive silvicultural technique must yield place to intensive treatment. Instances are not scarce, when the application of a particular silvicultural system has led in certain parts of the tract to temporary or even permanent set backs, because intensive silvicultural technique was not prescribed.

Emphasis has, however, been placed on economic costs and benefit of the improved technique. But it is at the same time a moot point because the changing facts of resource utilization can only be fitted in, provided the forest has been adequately inventoried. Nobody can adequately foresee what the future development will be. But if the survey has been adequate to give a picture of the growing stock, to the required fineness, planning is rendered easy. Therefore the more refined and adequate we can make our collection of facts, the better prepared shall we be for the selection and application of the silvicultural technique.

Principles of land use.

There is a general awakening regarding the importance of this subject but in an ancient land where the vast population has led to extreme fragmentation of land holdings the difficulties of enforcing proper land use policies are immense. The selection of the silvicultural technique is severely restricted due to the upper reaches of a catchment being under these holdings. Of late the problem has begun to be tackled by progressive legislation and propaganda. Techniques for land reclamation are being developed, more or less based on methods in use in the United States of America and Italy, the former in arable land and the latter in denuded forest land.

In dealing with denuded forest land variations of the trenching (Gradoni) technique have been tried with varying success. The chief problem here is effective closure to grazing. In fact effective closure alone has been found capable of yielding the major part of the resulting improvement.

But in a land teeming with cattle this problem is of considerable difficulty. It has not been rendered any the easier by the popular demand to throw open all land, other than closed areas under regeneration, to free grazing of cattle. Although there are certain restrictions they have fallen into disuse, as the main foundation from the villager's point of view has disappeared. The palliative of rotational grazing, attempted in several tracts has done nothing more than to demonstrate the futility of any measure which does not succeed in controlling the grazing incidence.

The principles of land use, however, deserve the higest priority, and above all the selection of the silvicultural technique must cater for this. Even forest conditions and management objectives should take second rank. These principles of land use should be employed, as has been hinted earlier, to sort out the individual parts of the tract on merits and status from considerations of geology, soil texture, degree and kind of slope. Valleys and slopes carved out of stratigraphic tiles, are for example in a class by themselves, for which the choice of the silvicultural technique if any is confined to the four corners of the Dauerwald. Stratigraphically dipping slopes and valleys, however, lend themselves to nearly unrestricted application of systems to suit the dual objectives of forest conditions and management targets.

How far silvicultural practices are telling in their effect on resource potentials is disclosed by a report of the soil conservation division in Madras. There is proof of the erosion of one foot of top soil in a tea plantation near Kotagiri, where clean weeding is practised, and also of some two inches of soil being eroded in pyrethrum fields in five years, and more in severe cases. In the last case clean weeding has been stopped.

Evidence is also forthcoming, from Madras again, of the wholesome effect of proper measures for the conservation of moisture. This is a cheap method of saucer depression in flat grounds, which conserve

moisture even from the lightest rain, making the the water flow towards the centre of the square, where planting is done on a small mound. The collection of water at the centre reduces superficial evaporation and promotes percolation into the soil. This has enabled the raising of *Casuarina equisetifolia,* on gently sloping ground, without irrigation. Attention is also invited to a modification of the Tummala method, where small (9 inches high) bunds run at an angle of about 45 degrees to the contour, intersecting and forming small 6 feet squares concentrating the water from light rain at one corner of each square, where sowing and planting give good results.

Silvicultural systems.

A silvicultural system is a tenchnique of forest management applied with due consideration to the silvicultural requirements of the species and aiming at the attainment of the normal forest and the establishment of regeneration to the normal extent. The categories of the systems are reasonably adequately understood, but a great deal has depended not on what one system actually is, in the text-book description, but on what has been left unsaid, and has been supplied by the individual worker's general knowledge and the experiences of the situation. Even if this were to lead to no disparity in actual interpretation, it would be untenable on logical grounds. To put it in other words, the premises must be clearly, adequately and unambiguously defined as a first requisite, so that uniformity is attained in majority of cases. It should not stop at first descriptions and accounts and whatever little advance an individual worker has made should be sifted and incorporated by a bureau and disseminated. The lack of this information has led to great difficulties. Add to that the problem of mixed forests and we have a good size up of the difficulties of the selection of the silvicultural technique.

Silvicultural systems are the means of bringing about the desired results in the condition and form of the crop. It is of the utmost importance, therefore, before we begin to think of selecting and using a system, that we have a complete definition of all the tried silvicultural systems and a knowledge of the complete up-to-date technical details. It is the purpose of this paper to bring out the nature of some of the aspects that need heavy underlining to obtain a measure of success that will be in the best interests, on a sustained yield basis. The implementation of the recommendations rests, however, as has just been pointed out, with the establishment of a bureau that will be responsible for the dissemination of the details and encouraging enquiries and discussions.

Another aspect that needs consideration in connection with silvicultural systems is the realignment of management objectives. The classic objectives were what might be called exploitation, but now we are aiming at something more definite, such as the production of raw material for the industries, or the alteration of the composition of the natural forest communities. In our tropical conditions such objectives are bound to give rise to tremendous problems in the domain of both autecology and synecology. This aspect of the importance of the ecological approach in tackling management targets is being realised, now fortunately at an early stage in our undertakings.

Exotics, the introduction of which was almost discouraged hitherto, are coming into favour again with the realisation that past attempts were possibly based on inadequate knowledge.

Forest types.

This leads to a consideration of the forest types and their ecology. The application of regular silvicultural systems commenced in 1880 in the United Provinces where the second phase of concentrated regeneration fellings was also initiated some 35 years later, and yet we seem to be hardly out of the wood. The classical failure of Sal (*Shorea robusta* Gaertn. f.) regeneration to the desired extent, in areas where it did not pre-exist naturally, inspite of large amount of experimental research, has resulted in a definite set-back, as the dismal fact remains that the 1880 so-called selection fellings still find currency for the problem areas.

In India the main cause of this state of affairs is the literal divorce of the working plan officer, from the silviculturist. The highest authorities complacently believe that the silviculturist is essentially a species of the genus " forest officer ", and that the latter can be converted into the former by only a governmental order of appointment. It is true that the working plan officer consults the silviculturist on statistical matters, but that is hardly the crux of the problem.

The working plan officer produces a jejune list of plant species, for what he calls his local types. He even makes now-a-days a reference to what he regards as the classical forest types of India, that was never meant to be a standard work of reference, having been largely compiled from a mass of such jejune lists in the working plans, and cautiously named by the illustrious author of that publication as " A Preliminary Survey of the Forest Types of India ". The essential preliminary, therefore, second in the order of importance, in the selection of the silvicultural technique is the publication of an authoritative account of the forest types of India, and of every country for that matter, giving full details deduced from adequate transect studies, and specifying the conditions favourable as well as unfavourable for the

:production of the dominants, including the co-ominants, in which work co-ordination should be entralised for each country and the fullest ooperation of the silviculturist obtained. The itter should not merely be asked advice on paper, ut forced to initiate work in the field, in the interest f uniformity and making use of up-to-date methods.

Instances have only to be looked for to show that ie listing of types superficially is seriously in rror, to which can be traced the failure of the selected lvicultural technique. It is needless to point out iat success is easily achieved when the selected chnique falls in step with the development of the pe.

ntegration of soil and biochemic research.

The subject of soil studies was mooted as early as ie early thirties, in India, to bring out its importance, it here again development has been in water-tight, mpartments. The soil, it will be admitted, has less an influence on a crop than the atmospheric gencies. The proper method of obtaining the best om the soil experts is to integrate their work with iat of the silviculturist and the working plan officer. hese proposals, however, require a great organiza-on to be brought into being, in which the analysis the soil and the biochemic analyst's craft will everyday fare for the integrated programme ivisaged, as essential preliminaries for the selection the silvicultural technique. But the guarantee in be confidently given, should there be need, that these basic needs are provided for, success will a foregone conclusion.

hinning research and statistics.

The next point demanding attention is research thinning. The method of approach for this item wholly experimental, with layouts that have the llest approval of the statistician. In this subject it a moot point whether cycles as well as intensities ight to be experimented upon, or whether impor-nce should be given to one or the other factor ily. The trend of the indications in the com-irative research thinning plots established by the orest Research Institute with the fractional quality iecks in *Shorea robusts* coppice crops is towards iriation with the fractional quality of the individual ot, over a certain range. That it should vary with iality has hardly been disputed in the past, but it a new trend to recognise that bands of the ictional quality are equally telling in their effect.

Statistics are the life-blood of silvicultural actices. But we are here stressing the statistics the other kind, in experimentation, and the design and lay out of tests. India has not been behind any country in the world in this matter, although this fact is possibly obscured by the fact that forestry the world over took to it later than agriculture. We are in full agreement with the expert statistician in basing our research only on accept-able layout and design, and following it up with proper statistical analysis of the resulting data. In partial enumeration, we have dabbled with the possibilities of systematic sampling, in place of the random one, that alone satifises the theory of proba-bility. We have accepted the compromise that the first set need only have a random selection, and that the pattern can be ubiquitously repeated for the remaining sets. But the theory of the subject still remains on the agenda of the statistician to work out.

Tree breeding

The silviculturist is fully prepared to advise on the technique for the artificial regeneration of a species, while recognising that barring attempts at afforestation, the selection of this method is usually an admission of failure to regenerate the forest naturally. In the interest of the protection of the crop from frost, *Loranthus* and other parasites the need has arisen of emphasising the selection of seed and stock from resistant forms. In India our work with the geographical races of teak has indicated that our problems of combating low temperature can within limits be met by using seed from the sub-tropical zones, whereas for growth potential there is a difference in performance, the competitors being Burma seed and local seed. For protection from frost in the young stage, local seed of the United Provinces proved superior to the Mysore tropical varieties, in the case of *Terminalia tomentosa*, W & A. In a way this seems to confirm the hypothesis that for frosty areas seed from the sub-tropical zone is the answer.

Applied research.

A last point that stares us in the face is whether the assumed need of suitable silvicultural technique is real or due to lack of knowledge of applied silvi-culture. There have been advances that cannot be ignored, in the field of silviculture, but perhaps there has been a common lack in their being rightly put to use. There are two methods that suggest them-selves as possible remedies. One is the centrali-zation of working plans; the other is the establish-ment of experimental forests in all the important types of forest, that will be the sole concern of the expert in silviculture, and which should be used as models for critical study by the working plan officer, as a preliminary to drafting his proposals.

SOIL EROSION, THE GREATEST BOTTLENECK OF OUR NATIONAL PRODUCTION

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SUMMARY

G 1114/Gn., G/255Gn., G/2610/Gn.—The evils of soil erosion are pointed out and illustrated by th happenings in America and the state of affairs in India, generally and the conditions on agriculture lands, in water reservoirs, water ways and harbours, during floods, of water supply, on pasture and fores lands. The losses to roads and bridges are pointed out. The havoc wrought by wind erosion is stated, an the impact on economic and social conditions traced.

The potentialities of soil erosion in slackening the pace of national production in various spheres have yet to receive wide spread recognition in our country. The word "Erosion" is still a strange term not well understood by the rank and file of our people. Even in well informed quarters, soil erosion is still regarded as some spasmodic phenomenon confined to those farms where the land, for unexplained reasons, is subject to excessive washing. Our people are so ignorant and simple minded that they realize little about the devastative processes of erosion and the average city dweller, with a complete lack of knowledge of this problem, never gives it a thought. If 88 out of 183 districts in our provinces have deficits, and if even the so called surplus districts are not getting a balanced diet, it is due to the fact that sheet erosion or top soil wash has been steadily undermining the physical basis of the agricultural enterprise of our Nation.

In the early thirties, the U.S.A. was exactly in a similar position as we are today in regard to the recognition of the menacing forces of erosion. American agriculture received a shattering blow as erosion made rapid inroads in all its fertile fields, and finally the violent dust clouds of May, 12, 1934 which were unprecedented in American history swept across two-thirds of the continent sifting through the screens of tall office buildings in New York city and finally moving out for hundreds of miles over the Atlantic ocean. This unusual phenomenon shocked the American people into a realisation that something was desperately wrong with their land. Since then a nation-wide agitation began in the Press, the Radio, the Platform and the Cinema bringing out the evil of erosion in all its ramifications. Mr. Bennett, Head of the Soil Conservation Service, described this wide-spread awakening in these terms. "The notion that soil wastage was anything more than a purely agricultural problem—a matter of the mechanics of farming — was generally rejected as the most apparent kind of nonsense. Soil Erosion is now generally recognised in the United States as a powerful and destructive force which directly or indirectly, affects the lives of every man, woman and child. It is understood now not as a freak of nature which occasionally turns up on isolated farms and ranches but as an almost continually active force which attacks countless fields, whole watersheds and broad farmin communities ".

With characteristic thoroughness and boldnes of approach, Americans launched a nation-wid programme of Soil Conservation, and within les than a decade they could achieve marvellous result by way of accelerated production.

The magnitude of the problem of erosion in ou country is quite apparent from our agricultura maladjustments. The extent of the area affecte can be assessed only on the basis of erosion and soi surveys as well as from investigations conducted a erosion experimental stations, located in the variou representative areas. In America, such detailed investigations revealed that, excluding only mountain and desert lands, a total of some 282,000,000 acre had been completely ruined, and an additiona area of 775,000,000 acres was being affected to some extent by the slow process of sheet erosion. Thus it was estimated that more than half of the 1,904,000,000 acres comprising the total land area of the United States had been affected by erosion in some degree. This survey did not take into account the extent of bad land which could be reclaimed for agriculture by suitable operations.

Such detailed investigations in our country should reveal even far more striking figures of the extent of damaged lands. These sore spots of our agriculture lie scattered across the length and breadth of our country, and taken together, they constitute a grim reminder of the power of destructiveness of the unharnessed force of wind and rain. The barren slopes, the yawning chasms of deep gullies, the dust bowls and the sweeping floods are the direct legacies of erosion. The dust gales of the Central Indian plains, the gullied slopes of the Deccan plateau, the rolling floods of the Bihar and Assam valleys and, above all, the famine o food, fodder and water that has been shaking our country to its heels are enough manifestations to open our eyes to the ravages of erosion.

The evil effects of erosion embrace a wide field of national activities. A brief discussion of its salient features will give us an insight into the magnitude of the problem.

Erosion deposits on agricultural lands.

When sloping crop lands and grazing lands are exposed to the vagaries of wind and water, at first the top soil and subsequently the erosion-exposed subsoil are carried in suspension by running water and dropped on low lying lands. Similarly wind-assorted sand blown from an unprotected field or a pasture may be spread over adjoining lands for many miles around. In the case of such deposition by wind and water, the finer, lighter and more fertile material is generally carried through long distances along reservior and channel bottoms or transported to the sea, leaving the less fertile and coarser particles on the agricultural lands. What is more, the subsoil material drawn from the gullies is usually of relatively unproductive character and it impoverishes the lower slopes and alluvial plains over which it is laid by the run-off water. Sand, gravel, and even boulders are often deposited on the productive low lands. Millions of acres in the black belt region of the Deccan and the alluvial lands of the Central Indian plains are being damaged year after year. Lands which should otherwise produce tons of grains and other crops have been losing their fertility due to erosional deposition.

Erosion deposits in reservoirs, waterways and harbours.

The erosional debris is not only menacing the agricultural lands but is also reducing the storage capacities of our reservoirs waterways and harbours, by collecting in immense quantities behind dams, on channel beds and harbour mouths. Such deposits cut short the useful life of these costly structures, and also in many instances tend to spread out the stored water and expose a broader surface to losses by evaporation. In the arid regions exposure of storage water to the warm dry air presents an exceedingly serious problem of evaporation. The damage to the costly structures due to sedimentation constitutes an irreparable loss to national production of food and power.

Sedimentation impairs the effectiveness of irrigation systems. It also forces many streams from their natural courses thus causing damage along the banks and accentuating the problem of flood control. Navigation is constantly threatened by shoaling. Expensive dredging operations are necessitated by the huge accumulation of silt carried from fertile uplands sometimes hundreds of miles away. The invidious process of soil erosions has been converting the nation's greatest heritage and valuable asset into a definite liability and menace.

It is therefore absolutely essential to take effective steps for the prevension of soil erosion and consequent sedimentation in regard to the many major and minor irrigation and power projects which are now being taken up for construction by our Governments.

Effects of erosion in floods.

Records of recent years reveal that floods in nearly every section of the country seem to have increased in frequency volume and velocity. With the rapid silting of the streams, the height of flow or flood-crest heights have necessarily shot up with devastating effect on adjoining low lands miles around. Erosion and floods develop concurrently with a cumulative force of destruction. With the exposure of the impervious subsoil or the barren rock due to *intensive soil erosion, run off* water moves with increased speed in the direction of stream channels. Millions of gullies, the road site ditches and drainage canals discharge concentrated tributaries of the run-off water into the branching network of streams and rivers carved out by nature, and the concentrated volumes of water with enormous suspended materials of soil and debris engulf the surrounding land taking a heavy toll of life and property. Even the hundreds of millions of furrows between crop-rows running up and down the slopes are gutters draining rain water of the land. Therefore wide-spread soil erosion and unwise farming practices which accentuate its progress are among the major influences lying behind the nation's growing flood problem.

Erosion and water supplies.

While the more humid regions have been the victims of destructive floods, the arid zones are subjected to the contrasting phenomenon known as drought. While in certain sections of the country erosion presents a problem of dealing with surplus run-off, the same phenomenon creates the contrasting problem of preserving water for undeground storage. Thus erosion is such a queer thing as to present such an apparently *contradictory dual role.*

While dealing with the problem of reservoir sedimentation, the question of depletion of surface stores of water in streams, reserviors and ponds has been explained briefly. Even more important than storage of water above the ground are the supplies beneath the surface. Surplus rainwater when trapped by suitable devices on land where it falls percolates through permeable soil, and either feeds off slowly to springs, streams or artesian wells, or is trapped depending on the underground conditions. These underground water supplies are the best sources of irrigation and drinking water in the drought areas, but by interfering with the normal process of intake and percolation, erosion depletes

the reservoirs of the soil both above and below the surface. The appalling water thirst of our urban and rural areas is surely ascribable to the diminishing level of the undeground water table.

Erosion on pasture and forest lands.

Erosion has made sharp inroads into the pasture and forest lands. With the indiscriminate felling of private forests and the overgrazing of the pastures, the uncovered soil is washed by the run-off streams or blown out by the dust storms. When the subsurface soil is exposed, the process of moisture infiltration is disturbed and the ground surface gets swampy puddled over by muddy water. Soil erosion and the declining cover become complimentary forces speeding up the costly process of vanishing resources.

Erosion damage to transportation systems.

Transport has always been a serious bottleneck in the development of our national resources. The backwardness of our rural areas is not a little due to the utter inadequacy of proper . communications. However, our Governments are at present embarking upon a heavy programme of highway and secondary road construction. These costly structures should necessarily be planned and protected in order to render them less liable to the hazards of erosion. The instances of highway and railroad embankments being washed away by the cutting of uncontrolled water and road washing by the overflowing drainage ditches are very common in our country. It has been estimated that more than 50% of the annual cost of highway maintenance is due to the erosion damage to the transportation systems. There is also the indirect damage attributable in part or entirely to erosion, such as bridges washed out and culverts choked with silt and rock.

Effects of wind erosion.

Violent dust storms are quite common in the arid zones of our country. When the trees grew few and far between with the rapid denudation of forests, and with the pulvarized type of ploughing, sand and silt are swept across by the sweeping gales and deposited over thousands of acres of range and crop lands, smothering plant life and eliminating whatever chances there may have been for a harvest or a cover of grass. In many instances, the blowing sands cover highways and form troublesome line drifts and sand dunes which stand as a constant menace to the adjacent farm lands.

Uncontrolled wind erosion does incalculable damage to grazing and agriculture. In addition, it is blanketting the house tops, the office buildings, the pavements, and is also endangering the lives of the motorists, blinding the pedestrians, and above all reducing the effective life of mills and machinery by clogging their vital parts.

Economic and social consequences of erosion.

The evil effects of erosion embrace the social, economic and physical life of the entire nation. Erosion is such a vicious process as would tend to lower incomes both on the farm as well as in the industry. It frequently leads to submarginality and abandonment of land and in extreme cases to rural migration. It also leads to lower national incomes and tax base, general, community disintegration, and similar maladjustments of a serious import in the economic and social life of the country.

The effects of erosion may be temporarily offset by other physical or economic nature. For example, the application of fertilizers may stimulate a land against the inroads of erosion, or similarly high prices may, for a time, compensate for high costs of production on land depleted by erosion. In the former case, failure to control erosion will result eventually in the complete removal of the top as well as the sub-soil. In the later case, uncontrolled erosion will eventually make it uneconomical or even impossible to gorw any crops on the bed-rock or the fields riddled by gullies

The inroads of erosion on the soil wealth of our country are so intensive and rapid that many rural communities are often driven to submarginal cultivation, but such unsound production finally strips the land of its remaining soil and then slashes it with gullies, leaving it impoverished or completely worthless for any further use. Community migrations are quite a common feature in our Central Indian plains and the Deccan plataeu.

Submarginal farming has become a common feature with the impetus given by the Government under the drive for increased food production, and also under the high level of industrial demand for cash crops. Such an intensive exploitation of erosion-eaten lands under the stimulus of intensive fertilization and with improved farm implements, will have deleterious effects on farming operations, in the long run.

With declining productivity of his land, and with mounting taxes, mortgages, and credit payments, the farmer cannot be an ally of urban industries in maintaining a healthy business cycle. When the production of food and raw materials becomes scarce, the impact of rural impoverishment will have telling effects upon the country's industrial development.

Summarizing the evil effects of soil erosion on national production and life. Mr. Bennett of the U.S.A. Soil Conservation Service says, "It can be said that the process, if uncontrolled, impoverishes the land, as well as communities and urban areas dependent in part or entirely on the welfare of the farmer."

A NOTE ON FORESTRY IN WEST BENGAL

BY S.N. MITRA D.C. FORESTS (RETD.)

Past History :

The early history of the forests of Bengal is much the same as that of many other countries and may be summarised in the words of Mr. F.C. Ford Robertson, D. C. of Forests, U.P. (*vide* page 4 of "Our Forests"), as "Primeval plenty eaten up by an expanding population, Government alarmed at the growing shortage, then enactments protecting the forest remnant and creating a department to restore and administer it. Destruction followed by conservancy—Shiva by Bishnu ".

Sometime about 1862 the Government of India awoke to the necessity of proper Forest-conservancy only when the vast primeval forests of this country were so far ruined by unrestricted private exploitation that the rapidly increasing demand for timber for private and State purposes, particularly for supply of sleepers to the different railways and of various requirements of the P.W.D., could no longer be met. Bengal (including Bihar and Orissa), being then the seat of the Central Government and thus the main centre of activities and expansion in trade and industries, was naturally the greatest sufferer in this respect. However, with the creation of the Forest Department in 1864 and with the passing of the first Indian Forest Act in 1865 (since superseded by Act VII of 1878 and again by Act XVI of 1927 which now applies to Bengal) the first steps were taken to protect from further ruin and conserve the remnants of our vast natural heritage. The forests then saved and made permanently inalienable in Bengal proper formed only 13.5 per cent of the total area of the province.

Forest Policy :

From the very inception of the Forest Department the Government forests in Bengal as indeed in all other provinces, have been tacitly managed on the principle of sustained yield so as to ensure that the outturn of forest produce is approximately equal from year to year or rises gradually till the maximum possible yield from the forest is obtained. This is necessary, for large fluctuations in the annual yield is very upsetting to the industries and the large population dependent on the forest in one way or another. This sound principle of sustained yield does not appear to have been embodied in the existing forest policy which was definitely laid down in 1894 (in Government of India's Circular No. 22 F, dated 19-10-1894) by the classification of the forests into four broad classes, *viz* :—

(i) Protection forests, *i.e.*, those necessary on climatic and physical grounds, *viz.*, storage of rain water and its even distribution to underground springs, prevention of erosion and sudden floods, etc. These are of very great importance for the physical protection of arable lands and maintenance of their productivity, not only in the immediate vicinity but also in areas far away from such forests ; for instance the whole of the Gangetic plain is affected by the treatment that is received by the forests on the Himalayas.

(ii) Timber producing forests, *i.e.*, those which principally supply timber for trade and industry.

(iii) Minor forests, *i.e.*, those producing inferior wood, fuel, fodder, etc. for local consumption in neighbouring villages. These are of prime importance in agricultural districts.

(iv) Pasture forests, *i.e.*, those which principally afford grazing and fodder.

This classification has nothing to do with the legal position of the various forests under the Forest Act, but indicates the lines of policy to be followed for management of the different classes of forest, which cannot, however, be sharply distinguished from each other. As a matter of fact every forest performs the function of a Protection forest to a greater or smaller extent and any particular forest may easily fall under more than one class.

" The outstanding principles of the above policy are :—

(a) that first and foremost the preservation of the climate and physical conditions of the country comes before anything else ;

(b) that the preservation of the minimum amount of forest necessary for the general well-being of the country is second only to (a) above.

But PROVIDED THE ABOVE TWO CONDITIONS are fulfilled, then :—

(c) cultivation comes before forestry ;

(d) the satisfaction of the wants of the local population free or at non-competitive rates comes before revenue ;

(e) after all the above are satisfied the realisation of revenue to the greatest possible extent is permitted . " (Para 12 of Sir Herbert Howard's note on the Post-War Forest Policy for India).

The policy is based on the principle of the greatest good to the greatest number and is almost unexceptionable. The only noticeable defects are :—

(i) non-inclusion of the principle of sustained yield and (ii) omission to lay down a fixed percentage of land to be kept under forest on a permanent and absolutely inalienable basis.

West Bengal can do no better than filling in these lacunae in the present forest policy and continuing to act on and implement it fully in all its bearings.

Effects of the Radcliffe Award :

It may incidentally be mentioned here that the Radcliffe Award has arbitrarily deprived West Bengal of her two very valuable forest assets, *viz*, the forests of the Chittagong Hill Tracts (1,286 sq. miles) and the Eastern Sunderbans (2,316 sq. miles).

In the Western Sundarbans we have no doubt representatives of most of the trees found in its counterpart, but they are too stunted in growth to be fit for anything but firewood and that too in meagre quantities. All that may be expected therefrom, at any rate until these forests can be radically improved, are very limited supplies of firewood, hantal, fish, shells, honey and wax. It should also be noted that parts of the Western Sunderbans are being badly eroded by the sea and thus the forest area gradually reduced. These considerations as well as the fact that more than 99 per cent of the revenue of the Sundarbans (about 6 lakhs in the pre-war days and 24 lakhs during the war) is derived from what part of it falls within the Khulna district, would give an idea of West Bengal's loss.

Forest Area :

The total area of West Bengal, as it stands after the recent partition, is 28,033 sq. miles and the total area of the Government forests in the various districts is 2,648 sq. miles, as detailed below :—

District.	Forest Division	Forest Area in Sq. Miles.
Darjeeling	Darjeeling	113
	Kalimpong	225
	Kurseong	112
Jalpaiguri	Jalpaiguri	193
	Buxa	375
24-Parganas	Western Sundarbans	1,630
	Total ..	2,648

Inadequacy of the existing forests :

Expert forest economists have estimated that for its physical and economic welfare, about 20 per cent of a country should be covered with merchantable forest. But the above figures go to show that the Government forests of this Province occupy only 9.4 per cent of its total area, out of which a large part, *viz.*, 672 sq. miles of the Western Sundarbans, consists of water. Deducting this, the actual forest-bearing land works out to just 7 per cent. Then again the whole of the Western Sundarbans is non-timber-bearing and at least 25 per cent of the forests in the Darjeeling Hills is too inaccessible or of too poor growth to be merchantable. Therefore, the commercially effective forest-land in West Bengal amounts to only about 905.5 sq. miles or 3.23 per cent of its total area. This compares very unfavourably with the average of 20 per cent (14 per cent merchantable) of India as a whole and 26 per cent of the European countries, and is far too short to satisfy the economic needs of this Province. This is also quite evident from the fact that Bengal is a heavy importer of timber and other forest product. To make West Bengal self-sufficient in the matter of supply of large timber, we have to increase our timber-forest area by at least 16.77 per cent or say, 4,700 sq. miles.

Bad distribution and its result :

Apart from their inadequacy, another noteworthy feature of the forests of West Bengal is their bad distribution. A glance at the map will show that they are confined entirely to the extreme North and South ends of the Province in mere fringes, far away from the main centres of population. As a matter of fact out of the 14 districts of West Bengal as many as 10 (excluding Calcutta) comprising of a population 1,41,36,000 have no Government forests and are, therefore, rather badly placed with regard to supply of small timber and firewood for the ordinary village consumer. Being unable to secure their requirements of timber for adequate dwelling houses and agricultural or industrial implements and of firewood from the distant forests at a reasonable cost, the ordinary villagers are compelled to live in miserable huts amidst squalor, go without proper tools and burn in place of firewood enormous quantities of valuable manure in the form of cowdung. Indeed the miserably low standard of living and public health, the enormous waste of man-power caused by the low vitality of the people and resultant diseases, and the progressive decline in the fertility and production of the soil are some of the direct consequences of the inadequacy and bad distribution of our forests.

Necessity of increasing the area under forest :

The southern fringe of forest, as it stands now, can play no part in the near future in meeting any demand for timber. Only the accessible parts of the northern forests can meet to a limited extent the demands of the agriculturists, industrialists and others for timbers of various kinds, such as, for house-

posts, agricultural implements, furniture, buildings, bridges, railway sleepers, power-transmission-posts, etc. The demands for timber are bound to increase by leaps and bounds in the near future with the rapid industrialisation of the country and improvement in the standard of living of the ever increasing masses, which are our declared and immediate national aim. Woefully inadequate as our forests are, even to meet the present demands, they have been heavily overfelled during the war years. It will take some years to nurse them back to their normal state, during which very little large-sized timber may be expected out of them. It is, therefore, certain that West Bengal will have to continue importing timber, perhaps in increasing quantities, for some years to come. We should make every possible effort to eliminate this heavy drain of wealth and make ourselves as far as possible self-sufficient in respect of our requirements of timber and other forest produce. As a forest-crop normally takes anything from 50 to 150 years to mature, we have no time to lose in framing a carefully thought-out plan to that effect and put it in motion. The only way to achieve the above end is to zealously protect and improve to its utmost productivity every inch of the existing Government forests and create fresh ones as far as possible out of such uncultivable wastes as may now be available.

Our requirements :

Now let us consider our requirements for firewood and grazing grounds. It is estimated that 10 acres of land can perpetually supply the demand of 100 persons for firewood and that at least 200 and 400 acres of grazing-land are required for every 100 heads of cattle and buffaloes respectively. Our requirements of land on this basis and available resources are as follows :—

	District	Population (in hundreds)	Area required for firewood (acres)	Cattle (in hundreds)	Buffaloes (in hundreds)	Area required for pastures (acres)	Land under Government forest (acres)	Uncultivated land excluding current fallows (acres)	Land not available for cultivation (acres)
1.	Burdwan	18,907	1,89,070	7,828	705	18,47,600	—	2,35,676	3,07,000
2.	Birbhum	10,483	1,04,830	6,183	329	13,68,200	—	1,40,768	1,86,000
3.	Bankura	12,897	1,28,970	7,295	1,021	18,67,400	—	4,02,088	4,37,000
4.	Midnapore	31,907	3,19,070	17,395	736	37,73,400	—	7,29,383	5,33,000
5.	Howrah	14,903	1,49,030	2,289	52	4,78,600	—	29,956	67,000
6.	Hoogly	13,777	1,37,770	4,884	113	10,22,000	—	72,588	1,33,000
7.	24 Parganas	36,695	3,66,950	11,371	429	24,45,800	10,43,200	3,28,580	4,28,256
8.	Calcutta	21,089	2,10,890	—	—	—	—	—	—
9.	Nabadwip	8,403	84,030	4,142	295	9,46,400	—	1,42,365	1,075
10	Murshidabad	16,405	1,64,050	6,156	463	14,16,400	—	1,75,000	1,82,537
11	West Dinajpur	5,835	58,350	4,489	517	11,04,600	—	1,05,444	80,471
12	Malda	8,443	84,430	3,022	263	7,09,600	—	95,119	1,38,820
13.	Japaiguri	8,457	84,570	5,252	363	11,95,600	3,63,520	3,27,256	1,87,611
14.	Darjeeling	3,764	37,640	1,024	110	2,48,800	2,88,000	3,230	2,94,300
	TOTAL	2,11,965	21,19,650	81,330	5,396	1,84,24,400	16,94,720	27,87,483	29,76,070
	Total areas in sq. miles		3,312			28,788	2,648	4,355	4,650
	Deduct 7,8,13 and 14 where firewood is available from Government forests.		1,094						
	Area required for firewood reserves		2,218 sq. miles.						

From the above figures it appears that :—

(i) It is not possible to make a separate allocation of adequate land to be used exclusively as pasture for the existing stock of cattle and buffaloes, for the total area of the province is only 28,033 sq. miles.

(ii) The additional 4,700 sq. miles required for production of large timber and 2,218 sq. miles for small timber and firewood, *i.e.*, 6,918 sq. miles in total, may be forthcoming from the 9,005 sq. miles of land available under the heads "uncultivated land excluding current fallows and land not available for cultivation". The former possibly includes the private forests, if any, and the latter includes swamps, water areas, roads, railways, embankments, homesteads, etc., separate statistics for which are not readily available. Hence it is not possible to say, without a detailed investigation, exactly what area out of these two categories of land may be suitable for afforestation. It is also not known how much of these lands belongs to the Government Khas Mahal and how much to private owners.

Private Forests :

West Bengal has private forests of limited areas in the districts of Jalpaiguri, Bankura, Birbhum, Burdwan, Midnapur, and perhaps Malda ; with some honourable exceptions most of these have

reached almost the last stage of denundation and been converted into nothing but scrub-jungles. Privately owned forests have virtually disappeared from the other parts of the province.

It has been the experience of almost every country in the world that private ownership of forests, however enlightened the owners may be, (as also monopolistic exploitation of State Forests by private trading concerns) always leads to their devastation and is, therefore, inconsistent with the interests and welfare of the country as a whole. Sooner or later many a country has found it necessary to exercise some sort of control over private ownership of forest-lands. The recent enactment of the Bengal Private Forests Act in 1946 proves that Bengal has been no exception to that.

The Bengal Private Forests Act provides for:—

(i) the compulsory management on proper scientific lines (under an approved working plan) of what are called "controlled forests, *i.e.*, such private forests which are manged well by their owners and are left to their management;

(ii) taking over the management of what are called "vested forests" *i.e.* such private forests the control of which is vested in a Forest Officer at the request of the owner or compulsorily in certain cases of mismanagement, and managing it on behalf of the owner for a period of 15 or a maximum of 30 years.

This Act has been in force for too short a time to show any appreciable result and it is doubtful whether it can do any permanent good in the present state of affairs. In any case it will be redundant on abolition of the Zamindari-system and nationalisation of the land which is expected to be effected in the near future. It will then be quite easy for Government to bring the present private waste lands under forest and increase the preserved forest area up to the minimum requirements of the province.

Objects of management:

The main objects of management of the State forests should be:—

(i) Perpetual supply at reasonably cheap rates of firewood, small timber and fodder to the agricultural villagers of all castes and creeds all over the province, with a view to raise their general standard of living and enable them to save the cowdung for its legitimate and more profitable use as manure.

(ii) Sustained supply of the largest possible quantity of timber and other produces to the industries and consumers in general, consistent with the permanent conservation of the forests, and making the province self-sufficient in this respect as far as possible.

(iii) Preservation of the local flora and fauna

Suggestions:

General:

For correct management and best utilisation of the land and water areas, a comprehensive ecological survey of the whole province by a central agency consisting of the representatives of the different departments of Government concerned and competent scientists is essentially and urgently necessary. The aim of the survey will be to:—

(i) determine and classify the different types and zones of climate, soil, water, agricultural crops, forest crops, fisheries, games, etc.

(ii) classify all the cultivated and uncultivated land on the above basis into different categories, and

(iii) allocate them accordingly to such purposes for which they are best suited in the interests of the nation.

As this is a complex and labourious affair, it is likely to take some time. For the present the details of uncultivated land ("uncultivated land other than current fallow" and "land not available flr cultivation") should be gathered from the existing settlement records and maps and tabulated under various heads, viz., forests or scrub jungles, open wastes, gardens, swamps, tanks, stream or canals, homesteads, buildings, roads, railways, sand dunes, rocky barrens, etc. All such items including the swamps and barrens, which could possibly grow some sort of a forest or pasture, should then be checked up in the field and made over to the Forest Department, if necessary, by acquisition. This is wanted immediately for making out a tentative plan for afforestation and starting creation of firewood and fodder reserves without further delay, particularly in the districts where there is no Government forest at present.

Firewood reserves :

About 2,200 sq. miles of permanent firewood reserves will have to be established in the 10 districts of the Province where there is no Government forest at present, as early as practicable. This measure from which the greatest benefit is expected to follow, is long overdue and so calls for immediate attention. It is particularly urgent for the 5 or 6 districts in which there is no vestige of forest, Government or private, at present.

The firewood reserves will necessarily have to be located as and where suitable land for them may be available. It is, therefore, very likely that they will not be as uniformly distributed as may be desired. But each reserve can and should be earmarked for a definite group of villages whose requirements can be

met conveniently from it. The urban population may have their requirements of fuel met by coal, gas and electricity.

The exact species to be sown or planted in these reserves will depend on the climatic, physical and edaphic factors of their locations. Generally speaking, the choice will lie on such indigenous quick growing species as can be worked on a rotation of 10 to 15 years, which, moreover, have a light crown so as to permit fodder-grasses to grow under them and are more or less disliked by cattle and thus less likely to be damaged by them. Fortunately there is no dearth of such species in Bengal to suit every kind of location.

Many of the indigenous fast-growing species which may be selected for the purpose of producing firewood on a short-rotation, are at the same time quite good for ordinary house-posts, agricultural tools, various cottage industries, etc.; for instance :—

Sissoo, White Siris, Gamar, Babul, Khair, etc. for lightly silted areas.

Jarul, Panisaj, Kainjal, etc. for water-logged areas. Pakasaj for moist clayey soil. Sal, Champ, Bamboos, etc., for high well-drained ground.

To avoid failure or loss through the attacks of insects or Loranthus, a mixed crop should be raised as a rule and at least one component of the mixture should be suitable for meeting the requirements of the villagers for small timber.

Timber reserves :

Besides maintaining the existing Government forests as timber reserves, about 4,700 sq. miles of new forest should be created, if at all possible, so that West Bengal may become self-sufficient in the matter of her requirements of large timber for the various industries, public works and general consumers.

Our forests are no doubt very rich in flora and we have some specific timber or other to suit almost every particular industry. But with one or two exceptions they all occur sporadically and are not available in merchantable quantities. For instance, although we have certain timbers which are quite good for matches, *viz.*, Simul, Pitali, Kadam, etc., these are found so few and far between in natural forests that their cost of extraction and transport is very high and there is not enough to go round. And as a result of this, the match industry in Bengal has to draw largely on timber imported from the Andamans, Assam and elsewhere. Such is the case with many other industries. It is, therefore, highly desirable that each of the new forests (or a set of new plantations in the existing forests) to be established in the future, should be such as to be able to give a sustained yield of material for a particular industry. In this way provision should be made for catering to the needs of such essential industries as manufacture of match, paper, bobbins and other small wooden parts of jute and cotton mills, packing cases, etc., and making the Province self-contained in this respect as far as possible.

Pastures :

The background in respect of pastures is as follows :—

Number of cattle according to 1940 census	81,33,088
Number of buffaloes „ „ „ „	5,39,549
Total	86,72,637
Area required for pasture for the above in square miles	28,788
Uncultivated land excluding current fallows	4,355
Land not available for cultivation ..	4,650
Current fallows	3,022
Area under reserved forests	2,648
Total area not under cultivation ..	14,675
Area normally under cultivation ..	13,358
Total area of the province	28,033

From the above it would appear that :—

(i) the area required as pasture for the present stock of cattle exceeds the total area of the Province support by about 755 sq. miles,

(ii) the entire uncultivated land (including the current fallows, reserved forests, land occupied by the railways, roads, buildings, etc.), can hardly even half of them.

The above is enough to explain the miserable condition of our cattle in general. The exact extent of regular full-time pasture that is afforded by the uncultivated waste is not known, but it cannot be more than a small fraction of the requirements, because the total area of the waste-land is only 4,355 sq. miles. The cultivated and, on the greater part of which only one crop is raised during the year the current fallows afford perhaps most of the grazing that our cattle get at present. But these part-time pastures are sure to be greatly curtailed as we intensify our efforts to grow more food by bringing the fallows under the plough and raising 2 or 3 crops a year where we are now raising only one.

No material amount of grazing can be expected from the existing reserved forests. The entire Sundarbans which forms 61·5 per cent of these forests, besides being too swampy, yield practically no fodder. The North Bengal forests are the only timber reserves we have got and these are also too precious as protection forest to be endangered in any way by grazing. The incidence of grazing in these forests, as given free to the cattle of the forest villagers and to those of the contractors and purchasers engaged on extraction of forest produce, is already pretty high. No more grazing can be allowed there without serious detriment to those forests. As a matter of fact, not to speak of admitting more grazing, it has always been found necessary to keep under a strict limit the number of the resident cattle and to prevent illicit grazing by outside cattle as much as possible.

The new timber-reserves, if any be created, can also furnish little or no grazing as it is totally incompatible with the creation, maintenance and regeneration of timber-producing forests.

The new firewood-reserves, as and when created and if properly managed, can furnish perpetual and good grazing over one-third to one-half of their total area, the actual proportion being determined by the rate of growth of the crop and the consequent rotation.

As our land-resources stand, we cannot possibly have sufficient firewood-cum-pastures-reserves or separate pastures to give adequate accommodation to the existing large stock of cattle and buffaloes for grazing. Solution of the acute problem of fodder-famine will, therefore, demand :—

(i) Elimination of all useless cattle and its replacement by superior stock so that we can meet our requirements with a greatly reduced number of them and consequently have less mouths to feed.

(ii) Encouraging the practice of stall-feeding cattle with dry and green fodder and silage.

(iii) Increasing the quantity and quality of fodder by systematic cultivation of grasses and legumes of high food value. Such agricultural crops, cereal or cash, which deplete the soil should be rotated with legumes which replenish the fertility of the soil and at the same time furnish rich fodder.

Conclusion :

Finally we have to remember that with the increase of population the per capita acreage of the country has been continously decreasing. Hence we must get out of each acre of forest land as much as possible of timber or firewood or fodder, as the case may be, without impairing or losing the land itself. Now that we have a national Government it is hoped that every possible measure will be taken to that end without undue delay.

CONTROLLED BURNING IN CHIR (PINUS LONGIFOLIA)

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SUMMARY

Controlled burning as a measure for securing immunity from late fires in forests of *Pinus longifolia* is now definitely regarded as indispensable. With the object of ascertaining the loss in increment due to this annual burn an experiment was started in 1936 in a young plantation of *Pinus longifolia* at New Forest, Dehra Dun. Examination of data over a period of five years, discloses the fact that there is no significant loss of increment in respect of either diameter or height in the burnt area compared with that of the unburnt area.

INTRODUCTION

The thick bark of *Pinus longifolia* (being as much as three inches in some cases) is a fire-retardant, but dry needles and resin are highly inflammable, and no forest officer who has charge of forests of this species can face with equianimity the onset of the hot weather, with no measures other than the ordinary that are taken for the protection of forests from fires by means of fire-lines, appointment of fire-watchers and declaring various acts of carrying and kindling fire in forests, illegal.

A fire run through the area, with due precautions, early in the season, down the hill, in crops that are not too young, is described as controlled burning. In certain provinces controlled burning has been practised since 1917 in the forests of *Pinus longifolia*. While the effects of even this mild form of burning the growth may to some extent be unwholesome to the well-being of the forest, the injury may be regarded as the premium paid for fire-insurance to save greater losses or even a holocaust, from a late fire.

It is, however, believed that the direct harm done by controlled burning is not very great. It would, nevertheless, be interesting to determine the extent of this loss and with this object in view an experiment was started in 1936 at the Forest Research Institute, on a small scale. The following account presents an interim report of this investigation.

LOCALITY AND INITIAL CONDITION OF CROP.

The area selected for the experiment consisted of compartments 23 and 24 of the *Chir* working circle of the demonstration area at New Forest, Dehra Dun. The crop consisted of crowded lines of *Pinus longifolia*, spaced six feet apart, raised from dense line sowings done in 1926. The soil of the locality is clayey with no defined profile. Annual rainfall averages 80 inches, with mild to severe frost from December to February. The elevation above mean sea-level is 2,200 feet.

The crop was thinned to B/C grade in 1934-35. The overwood consisted of *Pinus longifolia*, with a good deal of *Broussonetia papyrifera*, competing with it. The underwood contained *Cedrela toona Litsaea polyantha*, *Litsaea chinensis*, *Albizzia procera*, *Eugenia jambolana*, *Dalbergia sissoo* and *Mallotus phillippinensis*. Weed growth consisted of *Ageratum conyzoies*, mixed with patches of *Litsaea* species and the grasses *Sorghum halepense* and *Imperata cylindrica*.

DETAILS OF WORK DONE.

(a) **Initial treatment.** Compartment No. 23 was thinned to C grade in February 1936. Eight plots, each approximately one square chain in area, with adequate surrounds, were maked in two comparable sets of four plots each, separated by a strip 18 feet wide. Initial comparability between the two sets of plots was assessed on the mean height of ten well-spaced plants per plot and on the total number of stems above 3.0 inches in diameter at breast height.

The miscellaneous woody species in all the eight plots were enumerated by one-foot height classes and a strip one foot wide running through all plots equidistant from the mid-line of the 18 feet wide strip was selected and mapped to show the existing flora.

A quadrat 12 feet by 20 feet was marked out in the burnt area and another as identical as possible with it in the unburnt set for following the changes in the flora, which was mapped. All standing trees of *Pinus longifolia* in the eight plots were then measured up for diameter at breast-height.

The set of plots 1 to 4 were burnt at 2 p.m. on the 2nd April 1936. The fire lasted for half

an hour and the area was burnt satisfactorily. Flames ran up to 20 feet on some branchy trees burning the dry (frosted) ends of the needles. There was no drooping of leaders after the fire. The length of new shoots on the trees was estimated to be 9 to 18 inches.

In Compartment 24, C grade thinnings were done in February 1936 and six plots approximately one square chain each were marked out in two sets of three plots each, separated by a cleared strip 18 feet wide (electric power line). The two sets were, however, not initially comparable, but for tracing the diameter increment, comparable pairs of *Pinus longifolia* trees in the burnt and unburnt areas, have been used for analysis. The set of plots 4 to 6 was burnt on 2nd April 1936 and the recording of flora was done as for plots in compartment 23 but no quadrats were laid out.

(b) **Subsequent treatment.**

Plots 1 to 4 of compartment 23 and 4 to 6 of compartment 24 were burnt in April of 1937, 1938, 1939, 1940 and 1941. Strips in the burnt and unburnt set were mapped before the burning of the year in April and miscellaneous woody species in all the plots were enumerated. Diameter measurements of all trees of *Pinus longifolia* were recorded in April 1941.

Ground flora in the quadrats was mapped annually at the same time.

RESULTS.

Diameter increment of Pinus longifolia.

The 14 plots in the two compartments, 23 and 24 chir have furnished 355 comparable pairs of trees of *Pinus longifolia*. 129 pairs of trees belong to the diameter group 1.15" to 2.9" d.b.h. o.b. and 226 pairs to the diameter group above 3.0" *i.e.*, 2.95" to 5.0" d.b.h. o.b. The mean diameter increment in the course of five years from April 1936 to April 1941 amounted to 0.4" and 0.55" respectively for the burnt nd unburnt areas for the former and 0.89" and 1.02" respectively for the burnt and unburnt areas foi the latter. These increments are thus in favour of the unburnt plots, but are not significantly superior (at a level of 5%) as will appear from the statistical analysis in appendix III.

Two variations in the method of analysis were attempted *i.e.*, one for comparing separately for Compartments 23 & 24 the effect of burning on the diameter increments of stems 3.0" d.b.h. o.b. and above and the other for finding the effect of burning on diameter of stems 4.5" d.b.h. o.b. and over (considered suitable for paper pulp), with similar results.

Height increment of Pinus longifolia.

The height of 70 comparable pairs of trees were subjected to study in the 14 plots (appendix I). The average increments in the course of five years from 1936 to 1941 amounted to 11.2 ft. and 11.9 ft. for the burnt and unburnt plots respectively. In this case again while there is an increase of 0.7 ft. in favour of the unburnt plots, the difference is not significantly superior (at a level of 5%).

Effect of burning on woody species excluding Pinus longifolia.

Appendix IV shows the number of woody species other than *Pinus longifolia* found in the burnt and unburnt plots in the years 1937, 1938, 1939, 1940 and 1941, arranged under the families concerned. A curves showing the occurrence of species that furnished sufficient points for graphical representation is also given in the appendix. While it must be candidly admitted that the records vary in detail with the interest shown in botany by the respective recorders, there are certain points that can be deduced without fear of contradiction on that score in respect of two well-known species at least. *Murraya koenigii* is a well-known plant. The trend of the curves indicates that the plant flourishes in unburnt areas. On the other hand *Albizzia procera* flourishes in burnt areas.

Effect of burning on ground flora.

Appendix V shows the undergrowth mapped in the one-foot wide strips in the four years 1938 to 1941 and makes interesting reading. While great reliance cannot be placed on the results the indications are briefly discussed below.

Ageratum conyzoides is a weed the control of which is of considerable local importance. Burning seems to keep it in check. This indication is also supported by the study of the ground flora in the quadrats of compartment 23 (appendix VI). On the contrary *Sida acuta* seems to prosper in burnt areas. Burning does not seem to affect the occurrence of *Artemisia vulgaris*.

New colonists in unburnt areas are:—

Pogonatherum paniceun.
Flemingia congesta.

Desmodium tiliaefolium.

Boehmeria platyphylla.

Cynodon dactylon.

Imperata cylindrica, and other grasses prosper in burnt areas.

CONCLUSION.

Controlled burning in a young crop of *Pinus longifolia* caused no significant loss of increment in respect of either diameter at b.h. o.b. or height over a period of five years in comparison with a crop which was not burnt at all.

APPENDICES.

I. Height measurements in feet of 10 well-spaced plants of *Pinus longifolia* in each of the burnt and unburnt plots.

II. Comparison of number of stems of *Pinus longifolia* above 3.0" d.b.h.

III. Results of statistical analysis of differences in diameter and height increment of *Pinus longifolia* trees in the burnt and unburnt plots of compartments 23 & 24 Chir working circle.

IV. Table of frequency of occurrences of different woody-species during the years of observation.

V. Undergrowth, mapped and recorded by 1 ft. square.

VI. Frequency of occurrence of species in burnt and unburnt areas in quadrats in compt. *No. 23* Chir w.c.—

APPENDIX I.

Height measurements in feet of 10 well-spaced plants of **Pinus longifolia** in each of the Burnt and Unburnt plots.

1936

Compt. No.	No. of Sub-plots												Total
		BURNT											
23	1	19.7	26.0	19.5	23.5	18.0	19.0	20.0	24.0	20.0	24.0	213.7	
	2	19.4	23.4	20.0	18.0	18.6	21.1	20.8	20.0	19.7	20.0	201.0	788.3
	3	19.3	20.8	19.7	19.0	18.7	20.3	22.2	20.0	20.5	20.3	200.8	
	4	18.0	16.0	19.0	17.0	18.8	15.0	18.0	17.0	19.0	15.0	172.8	
24	4	22.0	16.0	21.4	15.0	23.0	18.8	20.0	18.6	19.3	22.0	196.1	
	5	19.5	22.0	18.0	22.7	22.3	19.5	23.6	22.8	20.7	20.0	211.1	609.4
	6	21.7	20.5	18.0	18.8	21.2	21.0	19.7	21.0	18.0	22.3	202.2	
													1397.7
													70
													Mean = 19.97
		UNBURNT											
23	5	17.5	19.0	17.5	15.7	15.0	23.0	14.5	19.8	18.5	16.0	176.5	Total
	6	18.8	18.0	18.0	20.0	19.8	18.0	19.0	18.8	23.2	20.0	193.6	776.7
	7	20.5	17.5	21.0	18.0	22.8	17.5	20.0	19.4	18.5	20.0	195.2	
	8	21.4	24.8	24.5	21.6	15.5	22.2	20.0	25.0	16.0	20.4	211.4	
24	1	21.8	23.4	22.2	17.0	19.0	15.8	22.7	18.0	15.8	16.3	192.0	
	2	18.4	20.3	15.8	19.3	19.3	14.0	17.0	19.3	17.5	23.0	183.9	572.2
	3	22.4	22.7	16.5	16.5	24.0	18.5	19.0	18.3	19.0	19.4	196.3	
													1348.9
													70
													Mean = 19.27

1941

Compt. No.	No. of Sub-plots												Total
		BURNT.											
23	1	31.5	36.3	31.3	33.2	33.7	28.0	27.7	33.8	32.6	34.6	322.7	
	2	26.7	35.4	33.7	27.5	27.4	32.6	29.5	30.9	31.6	33.3	308.6	1206.3
	3	28.0	33.5	30.1	30.5	32.2	30.2	33.8	29.6	30.6	32.4	310.9	
	4	29.0	24.3	28.8	26.9	27.3	23.2	28.0	24.3	30.5	21.8	264.1	
24	4	35.8	28.7	27.3	33.9	29.8	31.8	32.5	29.6	29.8	35.4	314.6	
	5	30.1	33.3	32.9	35.4	32.8	34.8	37.1	33.4	36.4	35.4	341.6	977.1
	6	30.8	29.7	31.8	31.5	34.3	35.8	30.3	29.4	30.7	36.6	320.9	
													2183.4
													70
													Mean = 31.19
		UNBURNT											
23	5	27.0	31.3	27.4	28.3	27.3	38.2	25.0	32.3	30.5	30.3	297.6	Total
	6	30.8	30.0	25.1	32.0	28.4	30.2	33.1	30.4	35.8	31.3	307.1	1255.6
	7	34.6	26.5	31.3	27.9	34.7	28.4	32.3	32.4	28.7	35.3	312.1	
	8	35.4	38.4	33.7	37.4	27.2	35.1	38.0	32.7	29.9	31.0	338.8	
24	1	33.1	35.3	35.9	27.9	30.2	31.3	24.7	28.8	34.8	30.8	312.8	
	2	31.4	31.0	27.8	28.7	25.8	30.6	28.8	29.8	29.4	36.6	299.9	926.0
	3	35.4	35.8	32.0	28.3	33.2	25.8	35.0	25.7	31.7	30.4	313.3	
													2181.6
													70
													Mean = 31.17

Calculations of sums of **squares.**

$$\Sigma \frac{(\text{Replication})^2}{10} = \frac{(213.7)^2+(201.0) - - - - (196.3)}{10} - \text{C.F.}$$

$$= 54079.55 - 53884.37 = 195.18$$

$$\Sigma \frac{(\text{Treatment})^2}{70} = \frac{(1397.7)^2 + (1348.9)^2}{70} - \text{C.F.}$$

$$= 53901.38 - 53884.37 = 17.01$$

Total sum of squares $= 54717.56 - 53884.37 = 833.19$

$$\text{C.F.} = \frac{(1397.7+1348.9)^2}{140} = 53884.37$$

Analysis of Variance.

				Calculated V_1/V_2	From table at 5% level of significance.	REMARKS.
Due to replications	6	194.86				
Treatments	1	17.01	17.01	3.61	3.91	Not significant.
Error	132	621.32	4.71			
Total.	139	833.19	6.00			

Thus there is no significant difference in the mean heights of trees in burnt and unburnt area.

As there is no difference in the mean heights further analysis is not necessary.

APPENDIX II.

Comparison of stems of *Pinus longifolia* above 3.0″ d.b.h.

Cept. 23, 1936.

BURNT				UNBURNT			
4.90	4.25	4.20	4.00	5.00	4.20	4.25	4.00
4.15	4.75	4.05	4.35	4.15	4.80	4.00	4.35
4.25	4.15	4.50	4.20	4.20	4.15	4.50	4.20
4.15	3.20	4.60	4.00	4.15	3.20	4.60	4.05
4.05	4.90	4.55	4.20	4.05	4.95	4.50	4.20
4.00	4.75	4.15	3.90	4.00	4.80	4.15	3.90
4.35	4.05	4.15	3.95	4.35	4.05	4.15	3.95
4.30	4.05	4.20	3.95	4.25	4.00	4.15	3.95
4.00	4.55	4.70	3.55	4.00	4.55	4.75	3.55
4.35	4.50	4.35	3.25	4.40	4.50	4.30	3.25
4.15	3.35	4.55	3.40	4.10	3.30	4.50	3.35
3.50	3.05	4.40	3.65	3.50	3.05	4.40	3.65
3.60	3.05	4.05	3.30	3.65	3.05	4.00	3.30
3.85	3.80	4.10	3.50	3.90	3.80	4.10	3.50
3.15	3.30	4.25	3.10	3.20	3.30	4.25	3.10
3.65	3.25	4.20	3.10	3.65	3.25	4.20	3.10
3.95	3.10	3.20	3.60	4.00	3.10	3.20	3.60
3.85	3.15	3.10	3.90	3.85	3.15	3.10	3.90
4.50	3.65	3.85	3.20	4.50	3.65	3.85	3.20
3.70	3.60	3.00	3.95	3.75	3.60	3.00	3.95
4.65	3.65	3.00	3.90	4.65	3.65	3.00	3.90
3.95	3.10	3.65	3.70	3.95	3.10	3.70	3.75
3.30	3.75	3.80	3.55	3.30	3.75	3.80	3.55
4.60	3.05	3.60	3.25	4.60	3.05	3.65	3.25
3.65	3.40	3.05	3.35	3.65	3.40	3.05	3.35
2.95	3.70	3.05	3.50	2.95	3.70	3.05	3.50
3.35	2.95	3.85	2.95	3.35	2.95	3.85	2.95
3.15	3.05	3.20	3.70	3.15	3.05	3.20	3.70
—	3.30	3.55	3.80	—	3.30	3.55	3.80
—	3.55	3.55	3.60	—	3.55	3.55	3.60
—	3.30	3.50	3.05	—	3.30	3.50	3.05
—	3.20	3.70	3.30	—	3.20	3.70	3.35
—	3.40	3.55	3.50	—	3.40	3.55	3.50
—	3.60	—	3.40	—	3.55	—	3.40
—	—	—	3.25	—	—	—	3.25

Total = 486.50   486.70
N = 130   130
Av. diameter = 3.742   3.744

Cept. 24, 1936,

UNBURNT.			BURNT.		
4.05	5.00	4.10	4.05	5.10	4.15
4.10	3.95	4.55	4.10	4.00	4.50
4.20	4.00	4.50	4.20	3.95	4.50
4.00	4.30	4.20	4.00	4.30	4.15
4.05	4.25	4.70	4.05	4.30	4.75
4.40	3.35	3.45	4.40	3.35	3.50
4.35	3.45	3.50	4.35	3.45	3.50
4.45	3.20	3.10	4.45	3.30	3.10
4.85	3.10	3.00	4.90	3.10	3.00
4.00	3.70	3.95	4.00	3.70	3.95
4.00	3.10	3.50	4.00	3.10	3.50
4.35	3.75	3.60	4.40	3.80	3.60
4.20	3.50	3.75	4.40	3.45	3.75
4.50	3.65	3.55	4.50	3.65	3.55
3.20	3.15	3.45	3.20	3.15	3.45
3.45	3.35	3.05	3.45	3.35	3.00
3.50	3.90	3.95	3.50	3.85	3.95
3.50	3.30	3.40	3.50	3.30	3.40
3.55	3.00	3.35	3.55	3.05	3.40
3.70	3.40	3.20	3.70	3.40	3.20
3.30	3.05	3.05	3.30	3.05	3.05
3.40	3.30	3.45	3.40	3.30	3.45
3.00	3.45	3.45	3.00	3.45	3.45
3.40	3.80	3.10	3.40	3.80	3.10
3.20	3.45	3.25	3.20	3.45	3.25
3.10	3.90	3.55	3.10	3.90	3.55
3.40	3.80	3.95	3.40	3.80	3.95
3.25	3.50	3.75	3.25	3.50	3.75
3.45	3.30	3.00	3.45	3.35	3.00
3.50	3.35	3.05	3.50	3.40	3.05
3.60	3.35	3.30	3.60	3.35	3.25
3.05	3.90	—	3.05	3.90	—
3.80	—	—	3.80	—	—

Total = 349.15   349.80
N = 96   96
Av. diam. = 3.63   3.644

Cept. 23, 1941.

BURNT.				UNBURNT.			
5.55	5.90	5.40	4.60	7.50	5.40	5.70	4.90
4.80	6.00	4.80	5.45	4.70	5.85	4.95	6.15
4.50	4.60	6.25	4.90	5.35	5.70	5.10	5.05
5.05	5.40	6.00	5.40	5.65	4.15	5.35	5.10
5.35	6.45	6.00	4.65	4.85	7.15	6.25	5.50
5.35	6.00	5.85	5.00	4.15	6.20	5.50	4.70
6.25	5.05	5.10	4.85	5.50	5.00	5.75	5.00
5.10	4.90	5.90	4.65	5.50	4.60	5.00	5.25
4.95	5.65	5.65	4.55	5.35	5.90	6.15	4.75
5.25	6.10	5.55	3.90	5.75	6.05	6.45	4.15
5.50	3.70	5.80	4.45	5.30	4.15	5.75	4.40
3.80	3.75	5.80	5.30	4.50	3.35	5.40	4.80
4.35	3.60	5.50	3.85	5.05	3.50	5.75	3.40
4.80	4.40	4.85	3.90	4.70	5.30	5.10	4.70
4.35	4.65	6.00	4.05	4.15	4.75	4.85	3.45
4.65	4.05	5.35	3.50	4.60	4.10	5.50	3.75
4.55	3.45	4.50	4.35	4.65	4.00	3.70	4.65
5.00	3.80	3.35	5.20	4.75	3.75	4.00	5.30
6.60	4.25	4.20	4.40	5.80	4.50	5.25	3.40
4.10	4.55	3.60	5.00	5.25	4.50	4.20	4.85
5.70	4.40	3.90	4.45	6.30	5.20	3.55	5.40
4.75	3.65	4.40	4.85	5.80	3.25	4.85	5.35
4.15	4.60	4.50	4.05	4.00	5.20	4.65	4.65
5.85	3.55	4.20	3.90	5.40	4.05	4.65	3.85
4.45	4.15	3.65	4.05	4.55	4.80	3.45	3.95
3.80	3.70	3.75	4.25	3.95	4.55	3.70	4.70
4.00	3.30	5.05	3.10	4.00	4.50	4.90	3.60
3.75	3.75	4.65	3.80	3.30	3.75	4.20	5.45
—	3.40	4.45	4.35	—	4.35	5.00	5.15
—	3.90	5.10	4.30	—	5.40	4.75	4.30
—	3.50	4.25	3.45	—	4.45	4.20	4.00
—	3.50	5.05	3.95	—	3.90	3.95	4.70
—	4.25	4.45	4.15	—	4.25	5.10	5.20
—	4.20	—	4.40	—	4.55	—	4.20
—	—	—	4.10	—	—	—	3.70

602.35 / 130 = 4.633   624.45 / 130 = 4.803

Cept. 24, 1941.

UNBURNT.			BURNT.		
5.60	6.00	5.90	5.20	6.50	5.85
5.40	5.60	6.00	5.60	4.70	6.30
5.75	5.15	5.80	5.60	5.15	5.80
4.50	5.65	5.50	6.10	5.10	4.85
4.80	6.10	7.00	4.95	6.05	5.85
5.75	3.95	4.10	5.85	3.85	4.20
5.90	4.05	5.05	5.95	4.50	4.25
5.80	3.80	3.80	5.85	4.10	3.85
6.75	3.65	4.15	6.45	4.25	3.40
4.60	4.70	5.60	4.90	4.65	4.55
4.35	3.85	4.00	4.95	3.85	4.49
6.00	5.15	4.50	5.55	5.10	4.20
5.10	4.60	4.90	5.05	4.45	4.75
5.95	4.45	4.40	5.45	4.45	4.95
3.85	3.70	3.95	4.15	4.40	4.60
4.85	4.30	3.65	4.65	3.60	3.40
4.10	4.70	5.10	4.25	5.30	5.70
4.30	3.70	4.25	4.80	3.95	3.80
4.50	3.60	5.05	4.40	3.55	3.90
4.20	4.05	4.55	4.70	4.20	3.65
3.50	3.60	3.85	4.05	3.95	3.60
4.30	4.45	4.45	4.00	3.95	4.70
3.70	4.40	4.40	3.45	4.75	4.45
3.80	4.65	4.05	4.00	5.15	3.65
4.45	4.30	4.20	4.00	4.45	3.85
4.15	5.20	4.65	3.75	4.70	4.25
4.50	4.95	5.75	4.10	4.40	4.20
3.80	4.55	4.75	3.60	3.75	4.35
3.95	4.30	3.45	4.20	3.35	3.30
4.15	4.55	3.60	4.20	4.75	3.65
4.20	4.65	4.30	3.80	3.90	3.85
3.70	5.45	—	3.80	5.00	—
4.25	—	—	4.35	—	—

Total = 445.00   435.60
N = 96   96
Av. diam. = 4.635   4.538

APPENDIX III. Results of statistical analysis of differences in diameter and height increment of *Pinus longifolia* trees in the burnt and unburnt plots of Compartments 23 and 24 Chir Working Circle.

Trees of diameters of 2.9″ and below.

Treatments.	No. of comparable trees.	Mean diameters. 1936	Mean diameters. 1941	Difference between means of diams.	"t" Observed	"t" Expected at 5% level of significance	REMARKS.
Burnt	129	2.40	2.80	0.13	1.60	1.96	The difference is not significant.
Unburnt	129	2.40	2.95				

Trees of diameters of 3.0″ and above.

Compartment No. 23 — Compartment No. 24.

	Comp. 23 BURNT. 1936	Comp. 23 BURNT. 1941	Comp. 23 UNBURNT. 1936	Comp. 23 UNBURNT. 1941	Comp. 24 BURNT. 1936	Comp. 24 BURNT. 1941	Comp. 24 UNBURNT. 1936	Comp. 24 UNBURNT. 1941
Total diameter	486.50	602.35	486.70	624.45	349.80	435.60	349.15	445.00
No. of trees	130	130	130	130	96	96	96	96
Mean diameter	3.74	4.63	3.74	4.80	3.64	4.54	3.64	4.64
Difference between mean diameters.	0	0.17				.10		
Sum of squares		82.5299		85.6891		57.6322		59.1900
Pooled sum of squares.	82.5299+85.6891=168.2190				57.6322+59.1900=116.8222			

Compartment No. 23

t, observed for 258 d.f. $= \dfrac{0.17}{\sqrt{\dfrac{168.2190 \times 2}{130 \times 129}}}$

$= \dfrac{0.17}{\sqrt{\dfrac{336.4380}{16770}}} = \dfrac{0.17}{\sqrt{.020062}}$

$= \dfrac{0.17}{.142} = 1.20$

t expected for $\propto$ d.f. = 1.96 at 5% level of significance.
Therefore difference is not significant.

Compartment No. 24

t, observed for 190 d.f. $= \dfrac{.10}{\sqrt{\dfrac{116.8222 \times 2}{96 \times 95}}}$

$= \dfrac{.10}{\sqrt{\dfrac{233.64444}{9120}}}$

$= \dfrac{.10}{\sqrt{.025619}} = \dfrac{.10}{.160}$

= 0.625 at 5% level of significance

t expected for $\propto$ d.f. = 1.96
Therefore difference is not significant.

Combining compartment No. 23 and 24, we get.

	BURNT.		UNBURNT.	
	1936	1941	1936	1941
Total diam.	836.30	1037.95	835.85	1069.45
No. of trees	226	226	226	226
Mean Diam.	3.70	4.59	3.71	4.73
Difference between mean of 1941 diams.		0.14		
Sum of squares		143.4120		148.1890

Pooled sums of squares. 143.4120+148.1890
=291.6010

"t" observed for 450 d.f.

$$= \frac{0.14}{\sqrt{\frac{291.6010 \times 2}{225 \times 226}}}$$

$$= \frac{.14}{\sqrt{\frac{583.2020}{50850.}}}$$

$$= \frac{.14}{\sqrt{.01145}} = \frac{.14}{.107} \text{ or } 1.31$$

"t". Expected for $\propto$ degrees of freedom at 5% level of significance $=1.96$

The difference is not significant.

Trees of diameters of 4.5″ and above.

	No. of comparaable trees.	Mean diameter		Difference between means of 1941 diam.	"t"		REMARKS.
		1936	1941		Observed	Expected at 5% level of significance	
Burnt	24	4.75	6.41	.29	1.19	1.96	The difference is not significant.
Unburnt	24	4.75	6.12				

Height measurements.

	No. of comparable trees.	Mean heights in feet.		Difference between means of 1941 diam.	"t"		REMARKS.
		1936	1941		Observed	Expected at 5% level of significance	
Burnt	70	20.0	31.2				No difference at all
Unburnt	70	19.3	31.2				

APPENDIX IV. Table of frequency of occurrences of different woody-species during the years of observation.

UNBURNT AREA.

URTICACEÆ.

Broussenetia papyrifera

Year.	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	1	19	28	29	29	19	159	284
1938	19	97	138	95	113	79	487	1023
1939	40	103	140	118	111	94	657	1263
1940	143	233	228	215	156	145	808	1928
1941	75	274	251	215	185	157	992	2149

Ficus palmata.

1937	—	—	1	1	—	1	—	3
1938	3	14	5	5	5	1	2	30
1939	5	12	3	3	3	4	3	33
1940	35	31	12	4	3	4	5	94
1941	22	27	12	6	5	5	5	82

Morus alba.

1937	—	—	—	—	—	—	2	2
1938	—	—	—	1	—	—	2	3
1939	—	—	2	—	1	1	2	4
1940	—	5	2	1	—	1	4	13
1941	—	2	4	3	—	1	4	14

MELIACEÆ.

Cedrela toona.

1937	22	24	26	8	7	1	18	106
1938	125	70	48	27	18	13	35	336
1939	321	142	44	38	24	15	44	628
1940	428	290	84	40	21	19	32	914
1941	321	419	143	49	20	20	20	1012

MYRTACEÆ.

Eugenia jambolana.

1937	13	2	—	2	—	1	1	19
1938	12	8	4	4	—	4	5	37
1939	17	21	10	4	1	1	8	62
1940	10	19	12	6	1	1	9	58
1941	11	10	19	9	6	2	9	66

	MALVACEÆ. *Bombax malabaricum.*								ANACARDIACEÆ. *Mangifera indica.*							
Year.	below 1′	1′—2′	2′—3′	3′—4′	4′—5′	5′—6′	Over 6′	Total	below 1′	1′—2′	2′—3′	3′—4′	4′—5′	5′—6′	Over 6′	Total
1937	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	2
1938	—	—	1	2	—	—	1	4	—	1	1	—	—	1	—	3
1939	—	—	2	2	—	3	2	9	—	—	1	—	1	—	1	3
1940	—	2	2	1	1	—	5	11	—	—	—	1	1	—	1	3
1941	—	1	1	3	—	1	4	10	—	—	—	—	1	1	1	3

	APOCYNACEÆ. *Carissa opaca.*								LYTHRACEÆ. *Woodfordia floribunda.*							
1937	—	—	2	—	—	—	—	2	—	—	—	1	—	—	—	1
1938	1	—	1	2	1	—	2	7	—	—	—	—	—	—	4	4
1939	2	2	—	—	—	—	—	4	—	—	—	—	—	—	—	—
1940	—	—	1	—	—	—	—	1	—	—	—	—	—	—	3	3
1941	6	8	2	1	2	—	—	19	—	—	—	1	—	—	4	5

	LABIATÆ. *Colebrookia oppositifolia.*							
1937	—	1	1	—	—	—	—	2
1938	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—
1940	—	—	—	—	2	2	3	7
1941	—	—	—	—	—	—	—	—

BURNT AREA.

URTICACEÆ.

	Broussonetia papyrifera.								*Ficus palmata.*							
1937	1	15	21	36	16	22	66	177	1	—	1	—	2	—	1	5
1938	91	103	135	156	141	124	585	1335	3	11	4	—	—	—	1	19
1939	142	150	206	216	198	171	735	1818	18	11	2	1	—	—	1	33
1940	144	184	281	302	202	190	680	1983	2	17	3	6	2	—	—	30
1941	121	171	192	294	299	303	790	2170	6	17	13	2	1	—	—	39

LEGUMINOSAE.

Dalbergia sissoo. — *Albizzia procera.*

Year.	below 1′	1′–2′	2′–3′	3′–4′	4′–5′	5′–6′	Over 6′	Total	below 1′	1′–2′	2′–3′	3′–4′	4′–5′	5′–6′	Over 6′	Tot
1937	—	1	1	3	3	4	53	65	3	2	3	2	1	—	4	15
1938	—	3	5	4	4	3	61	80	—	—	7	1	2	—	8	18
1939	—	2	8	4	4	7	53	78	3	4	3	4	1	2	11	28
1940	3	12	9	22	13	8	52	119	—	5	4	3	1	1	14	28
1941	11	23	38	24	20	12	61	189	2	1	3	2	1	—	11	20

LAURACEÆ.

Litsaea chinensis. — *Litsaea polyantha.*

1937	—	—	—	—	—	—	—	—	19	21	12	2	3	3	2	62
1938	137	98	12	2	1	—	—	250	12	15	14	3	7	8	10	71
1939	161	123	35	6	1	—	—	476	29	22	13	4	9	5	20	102
1940	112	128	34	14	6	1	1	296	73	46	22	20	3	2	7	173
1941	92	93	47	21	8	7	1	269	71	55	20	11	11	7	18	193

MYRTACEÆ. — EUPHORBIACEÆ.

Psidium guava. — *Mallotus phillipinensis.*

1937	2	4	—	—	—	—	—	6	5	1	—	—	—	1	2	9
1938	—	3	3	2	2	1	—	11	11	9	5	3	—	2	2	32
1939	—	1	1	—	2	2	1	7	18	22	13	2	3	2	3	63
1940	—	4	4	—	—	2	3	13	22	42	9	12	3	2	4	94
1941	1	3	3	2	—	1	4	14	17	32	15	11	7	7	6	95

URTICACEÆ. — RUTACEÆ.

Ficus hispida. — *Murraya koenigii.*

1937	—	3	3	1	—	—	—	7	3	1	—	—	—	—	—	4
1938	—	—	1	1	1	1	2	6	—	1	2	—	—	—	—	3
1939	4	2	1	—	2	3	5	17	31	11	3	1	—	—	—	46
1940	5	2	6	1	—	—	10	24	49	14	7	1	1	1	—	83
1941	3	2	5	6	1	—	8	25	40	20	6	4	4	4	2	78

URTICACEÆ. — MELIACEÆ.

Morus alba. — *Cedrela toona.*

Year	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	—	1	—	—	—	1	3	5	6	26	27	20	14	4	17	97
1938	1	1	2	3	—	—	3	10	379	134	31	39	31	20	18	652
1939	3	1	3	4	4	—	4	19	284	211	135	65	24	11	9	739
1940	18	4	1	2	4	6	4	39	175	237	251	94	53	11	13	834
1941	3	1	4	3	7	13	17	58	169	257	199	138	54	27	12	856

LAURACEÆ.

Litsaea polyantha. — *Litsaea chinensis.*

Year	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	15	13	10	1	2	—	1	42	226	12	—	—	—	—	—	238
1938	50	26	18	17	9	1	6	127	346	114	27	1	—	—	—	488
1939	50	34	23	15	17	4	2	145	320	133	53	15	—	—	1	522
1940	60	42	25	19	11	6	4	167	203	161	53	22	3	—	1	443
1941	38	33	29	38	14	5	3	160	143	149	92	38	18	3	1	444

LEGUMINOSÆ.

Dalbergia sissoo. — *Albizzia procera.*

Year	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	—	1	1	3	3	5	27	40	—	—	2	—	—	—	6	8
1938	5	18	10	6	2	4	23	68	3	4	1	2	1	2	6	19
1939	—	6	5	2	—	1	11	25	1	5	9	6	3	2	3	29
1940	—	9	25	14	12	2	15	77	—	3	8	10	2	2	11	36
1941	18	39	51	26	18	4	12	168	—	5	7	4	4	7	9	36

MYRTACEÆ.

Eugenia jambolana. — *Psidium guava.*

Year	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	7	1	—	6	4	—	3	21	1	—	—	—	—	—	—	1
1938	4	4	4	2	3m	—	3	20	—	—	1	—	—	—	—	1
1939	91	10	4	—	1	1	1	108	2	1	—	—	—	—	—	3
1940	21	7	4	3	—	—	4	39	1	—	—	1	—	—	—	2
1941	25	7	4	1	1	2	2	42	2	1	—	—	—	—	—	3

EUPHORBIACEÆ. — RUTACEÆ.

Mallotus phillipinensis. — *Murraya koenigii.*

Year	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total	below 1'	1'–2'	2'–3'	3'–4'	4'–5'	5'–6'	Over 6'	Total
1937	5	5	3	—	2	1	3	19	—	—	—	—	1	—	—	1
1938	9	13	6	5	1	1	3	38	11	5	—	—	—	1	—	17
1939	24	21	10	1	4	1	2	63	46	7	—	—	1	—	—	54
1940	28	19	18	7	2	1	3	78	41	10	2	1	1	—	—	55
1941	26	16	15	10	8	2	2	79	33	15	6	—	2	—	—	56

APPENDIX V.

Undergrowth, mapped and recorded by 1 ft. square.—

	UNBURNT				BURNT.			
	1938	1939	1940	1941	1938	1939	1940	1941
List of species which remained unaffected.								
Ageratum conyzoides	493			414	193	207	203	104
Sida acuta	13	1	11	14	32	68	69	82
Nepeta ruderalis	2	9	4	2	14	29	36	47
Artemisia vulgaris	4	4	4	3	5	2	3	3
List of species that progressed or appeared later.								
Urena lobata	3	25	27	28	5	7	1	—
Clerodendron infortunatum ..	7	10	19	19	—	—	—	—
Imperata cylindria	—	45	45	44	—	68	122	168
Sorghum halepense	—	4	4	3	23	42	25	41
Oplismenus compositus ..	—	46	116	247	—	21	61	105
Cissampelos pareira	—	1	1	2	6	1	3	1
Pogonatherum paniceum ..	—	—	—	5	—	—	—	—
Oenothera rosea	—	—	3	4	—	1	1	2
Melilotus indica	2	2	2	4	48	19	2	—
Carissa opaca	—	—	1	1	—	—	—	—
Rubia cordifolia	—	—	3	2	2	1	2	
Dicanthium annulatum ..	—	—	—	5	—	—	—	12
Flemingia congesta	—	—	—	4	—	—	—	—
Ficus palmata	—	—	—	1	—	—	—	—
Tinospora malabaricum ..	—	—	—	2	—	—	1	—
Flacourtia cataphracta ..	—	—	—	1	—	—	—	—
Rungia parviflora	—	—	—	9	—	—	—	144
Jasminum pubescens	—	—	—	1	—	—	—	2
Desmodium tillaefolium ..	—	—	—	9	—	—	1	—
Bombax malabaricum	—	—	—	1	1	1	1	1
Boehmeria platyphylla ..	—	—	—	8	—	—	—	—
List of species that deteriorated.								
Cynodon dactylon	20	9	8	7	60	62	35	37
Grasses	19	10	11	2	30	3	36	66
List of species finally disappearing.								
Chloris barbata	11	8	—	—	2	2	1	—
Hemarthria compressa	8	6	7	—	29	20	25	—
Oxalis corniculata	9	1	7	—	22	1	9	2
Flacourtia ramontchi	2	—	—	—	—	—	—	—
Acalypha indica	—	2	9	—	—	145	216	40
Achyranthes aspera	—	5	5	—	23	9	2	—
Aerua scandens	—	—	1	—	3	1	1	—
Cyperus rotundus	—	1	5	—	38	33	26	7
Justicia simplex	—	2	5	—	9	23	81	—
Ziyphus jujuba	2	4	3	1	1	2	2	2
Vicia hirsuta	—	8	—	—	—	6	—	—
Vicoa vestita					—	—	2	—
Hydrocotyle asiatica					21	3	1	3
Ficus glomerata					—	—	1	1
Sapium sebiferum					—	—	5	2

APPENDIX VI.

Frequency of occuruence of species in Burnt and Unburnt areas in quadrats in compt. No. 23 Chir are :—

Species		1936	1937	1938	1939	1940	1941
Ageratum conyzoides	Unburnt	37	61	60	60	60	60
	Burnt	15	38	29	40	42	17
Artemisia vulgaris	Unburnt	12	4	—	—	4	1
	Burnt	3	2	1	2	1	1
Sorghum halepense	U. burnt	21	4	—	2	3	—
	Burnt	17	31	34	35	34	35
Acalypha indica	Unburnt	39	—	—	6	2	—
	Burnt	15	41	61	57	58	1
Achyranthes aspsra	Unburnt	2	3	2	2	—	—
	Burnt	—	—	—	—	—	—
Cynodon dactylon	Unburnt	20	4	2	2	1	—
	Burnt	4	4	5	6	4	—
Cyperus rotundus	Unburnt	2	4	—	1	1	—
	Burnt	—	—	—	1	1	—
Hydrocotyle asiatica	Unburnt	4	3	2	5	5	9
	Burnt	1	2	—	—	—	—
Justicia simplex	Unburnt	23	2	—	1	—	—
	Burnt	6	—	—	16	23	—
Rotboellia compressa	Unburnt	21	29	—	—	—	—
	Burnt	8	18	2	—	—	—
Phyllanthus urinaria	Unburnt	34	—	2	—	—	—
	Burnt	14	4	37	—	—	—
Nepeta ruderalis	Unburnt	3	—	—	—	—	—
	Burnt	15	—	3	9	10	—
Verbenao fficinalis	Unburnt	2	—	—	—	—	—
	Burnt	—	—	—	—	—	—
Oplismenus compositus	Unburnt	—	—	—	3	5	19
	Burnt	—	—	8	31	42	22

List of species and their frequencies in Burnt area, but not found in Unburnt area.

Cassia tora	2	1	5	4	1	—
Euphorbia hirta	1	—	—	—	—	—
Ipomea hederacea	1	—	—	—	—	—
Sida rhombifolia	3	10	—	—	—	—
Urena lobata	1	3	3	12	3	—
Zizyphus jujuba	2	10	17	18	14	12
Physalis minima	5	—	4	—	—	—
Hemarthria compressa	—	—	21	14	37	—
Dioscorea	—	—	1	—	—	—
Malvastrum tilaefolium	—	—	1	3	—	—

PROTECTION OF FOOD CROPS AGAINST WILD ELEPHANTS IN MYSORE DIVISION

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In many parts of Mysore damage to food crops by wild elephants has been continuously on the increase in recent years. This is due, to some extent, to the understricted multiplication of this largest land animal, but is more so owing to the fact that with increase in human population and the consequent spread of cultivation into the interior portions of forests, where the wild elephant has its home, cultivated land came within easy reach of the territory over which the wild herds are accustomed to roam.

The primary object of the elephant scaring operations is to protect food crops like **ragi** (*Eleusine corocana*), called **mandwa** in Uttar Pradesh, and rice from being trampled and destroyed by herds of wild elephants which roam freely over the forests of Hunsur, Periyapatna, Heggadadevankote, Nanjangud and Chamarajanagar taluks of Mysore district. It is generally believed that owing to the opening up of our forests by making an extensive network of roads and the resulting distrrbance to wild animals, elephant herds get scared and driven out of their natural haunts; they therefore wander into open fields containing food crops. It is also stated that once the elephants taste the juicy food crops which are easy to pick up and eat, and also taste better than jungle fodder, they become habitual depredators of food crops and make their unwelcome visits into fields their daily routine. This statement is, however, not quite correct because, it is on record that more than sixty years ago, during the eighties of the last century, an Englishman by name Sanderson came to Mysore at the request of the Ruler of Mysore and was entrusted with the work of capturing wild elephants by the well known *Khedda* method *with a view to give relief to raiyats from their havoc.* In those days the forests had not been opened up as now; there was hardly a cart track fit for wheeled traffic and roads of the modern kind were totally absent; yet, elephant herds are reported to have invaded the fields and destroyed food crops on a large scale. Some time later, the Government of Mysore instituted what is called a *Khedda Department* and placed it under a "Superintendent of Kheddas". Sanderson was the first head of this Department, the sole work of which was to conduct *Khedda* operations regularly with a view to capture as many wild elephants as possible in order to reduce, if not stop, their mischief. This Department was in existence for about three decades and was finally abolished about the year 1908. Its place was filled up, sometime later, by the newly formed *Game Branch* of the Forest Department but this was meant for the conservation of game and the systemâtization of the shikars of tiger, panther, bison etc. more than for elephant captures.

On the abolition of the *Khedda* Department, the Forest Department took over its work and managed the subsequent *Khedda* operations, with the assistance of the Game Branch, which was subordinate to it. Within a few years, however, wild elephants multiplied enormously and the want of adequate measures for the protection of food crops began to be keenly felt. The Game branch undertook this protection for some time but found itself unequal to the task. This work was then entrusted to the Forest Department proper. Very soon special elephant scaring staff was appointed and stationed at various centres where the mischief of elephants was most common. In still more recent years, owing to the encouragement given by the Government for the expansion of cultivation under the Grow More Food scheme, patches of cultivation sprang up at all odd places in the heart of the jungles, where none existed before, and their protection from wild animals, especially elephants, became an acute problem.

The word **Khedda** or **Kheda** comes from the hindustani word '*Khedda*' meaning a trench. Essentially the Mysore *Khedda* operations, which for their magnitude and grandeur are unrivalled in any other part of India or beyond it, consist in skillfully directing the movements of a wild herd with the help of men and *Kumki* (trained) elephants into a small enclosure, called *Khedda* enclosure, which is surrounded by trench about 9 ft. wide at the top and tapers to about a foot at a depth of 8 to 9 ft., which the wild elephants are generally unable to cross. The weak points in the trench are reinforced by constructing a palisade of upright wooden props each of which is about two feet in girth and is sunk 3 feet or more into

the ground at 2 to 3 ft. intervals, while its free end stands 10 to 12 ft. above ground level; (Fig. 1); these uprights are strengthened by fastening to them with coir ropes thick cross pieces of wood about a foot in girth and several feet long. Two or more trap doors, which open inwards and are carefuly camouflaged with green leaf at the time the wild herd is driven into the *Khedda* surround, provide entrance and exit into it. The trap doors, which are about 12 to 14 ft. wide and high, (Fig 2), are constructed according to a design which was originally invented in Bengal (Chittagong and introduced into Mysore by the *mahouts* (elephant capturing men) who hailed from that locality. In the past two to three decades, major *Khedda* operations were held in Mysore generally once every five years, to provide pastime to a series of British Viceroys during their official visits to the State (Fig 3), and incidentally also to reduce the number of elephants, but in very recent years the operations were undertaken more with a view to provide relief to agriculturists from the depredations of these troublesome animals against food crops. The writer has been actively associated with practically every *Khedda* operation, major or minor, which has taken place in Mysore State during the last twenty two years. The latest among the more brilliant of the series of operations, which were organised by the writer and conducted under his personal supervision, took place during the last days of 1948 and the first two weeks of 1949 when, for the first time in the history of the Mysore *Kheddas*, the Prime Minister of Independent India graced the occasion with his august presence and spent some cheerful hours watching the drive of a wild herd upstream along the Kabini river, its subsequent capture behind a *Khedda* trench and the final roping of a wild tusker fresh from the forest (Fig 4).

Before dealing with the measures taken to protect cultivation, it would be appropriate to narrate some interesting details about the life history of the elephant because, though most, if not all people in this country, may have seen an elephant at some time or other during their lifetime, yet few know much about its habits and ways of life; fantastic elephant stories are therefore generally current among school boys and grown-ups. One will also be able to appreciate the practical difficulties which the elephant scaring operations present if he knows something about the habits of this animal.

The Indian elephant (*Elephas maximus indicus*) rarely exceeds 10 ft. - 6 in. at the shoulder. The average male is about 9 feet; the female is generally lower, by about a foot. In the case of full grown animals, twice the circumference of an elephant's forefoot often given a fair indication of its height and this helps a shikari to estimate the size of an animal which he has not actually seen. The male Indian elephant has large tusks. The tusks of the female are rudimentary and scarcely protrude beyond the upper lip. Some males are also tuskless like the females and such animals, called *maknas*, are large in build with extraordinarily well formed trunks. The contour of the tusks varies; they may be upcurved and almost parallel, they may also converge or diverge or they may grow straight and point downwards, or the individual tusks may grow in different ways. Very well grown tusks may measure 8½ feet in length and weigh about 160 lbs.*

The Indian elephant has normally five nails on its fore foot and four on its hind. Ordinarily only three nails leave their imprint on the ground. The colour of the elephant is greyish black. The chest, the forehead and the ears are often covered with flesh coloured spots due to want of pigmentation. The spots become more prominent with age, and sometimes extend to the whole face, proboscis, chest and trunk. Albino elephants (whitish elephants), which have little pigmentation in their skin also exist.

The elephant usually moves at a walking pace, but breaks into a shuffling run if alarmed or annoyed. Inspite of its bulk, it can attain a speed of quite 20 miles per hour, but only over short distances.* Despite its bulk, it is also a wonderfully active animal and goes up and down steep hill-sides with ease and gradients up to 70° do not baffle it. On still steeper ground it slides down on its haunches, but cannot go up. It is an excellent swimmer and in deep water swims with practically the whole body, except part of the trunk and the head, submerged.

In Mysore State, the home of the elephant is the high forest covering the hilly and undulating ground all along the frontier of Mysore division adjoining Coorg, Malabar and Wynaad, where bamboos grow in profusion. Stray elephants or even herds coming from the ad-

*From the Journal of the Bombay Natural History Society.

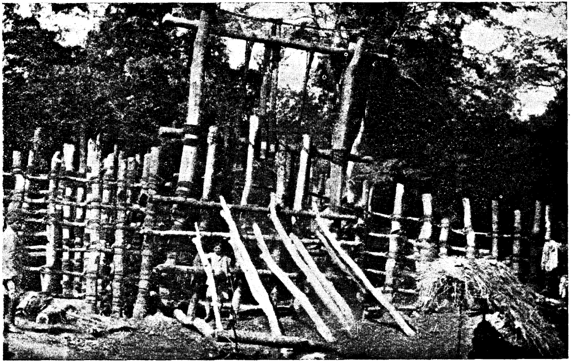

Fig. 1.

The *Khedda* trap-door closed and made fast with cross pieces and forks to prevent its being forced open by the wild herd inside. The forks are of *Anogeissus latifolia*, a wood known for its extra-ordinary toughness in such use. Notice the smoking fire in the foreground which is put there to scare the wild elephants from the gate if they should happen to approach it. Observe also the construction of the *Khedda* stockade on either side of the gate.

Photo—AUTHOR
Irwin-Khedda, 1929.

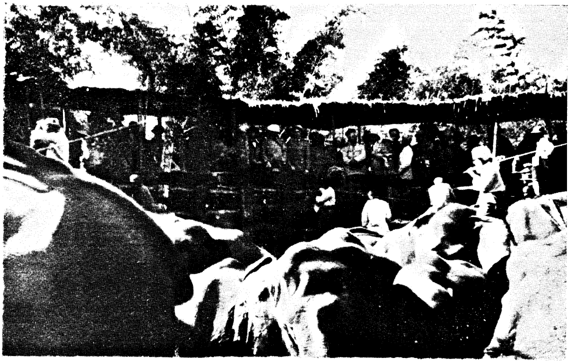

Fig. 4.

Roping of the captured wild elephants in progress within the roping ring. *Mahouts* riding *kumkies* (tame elephants) get into the roping ring where the wild ones have been previously impounded, and slip stout hemp ropes on to the necks and legs of the wild ones. This risky operation provides a lot of fun to the onlookers.

Photo—AUTHOR

Fig 5.
A wild herd sighted in the forest by a driving party but slightly disturbed and therefore rapidly getting away.
Photo—AUTHOR

Fig. 6
Close-up view of a portion of a wild herd. The suspicious leader, invariably an old female, who is ever on the watch, is facing the camera while the others are grazing unconcernedly. Photo—AUTHOR

joining Indian · territory visit portions of Bangalore, Hassan, Kadur and Shimoga districts. They are able to withtand great variations of climate and rainfall and thrive equally well in the hot humid sea-level forests of the Arabian Sea coast and in the tableland forests of Mysore State at elevations of 3,000 feet or over. In high summer the herds keep to the neighbourhood of water, running or stagnant, and remain in the denser portions of the jungle where there is ample shade but, during and after the rains, they come out into the open and frequently enter cultivation. Individuals of all sizes and ages from sucklings to very old cows are found in the herds which may contain up to sixty animals or more (Fig.5). Herds are said to be composed of single families. Different herds do not generally mix but stray females and young males do pass from one herd to another. This is, perhaps, nature's way of preventing inbreeding. During summer and at times when fodder is scarce, the larger herds break up into smaller parties which reunite when conditions are again favourable. The big tuskers are usually found feeding some distance away from the main herd. The tuskers, when they reach a certain age, live as solitaries, or rarely two males more or less of equal age associate together. The solitary, full grown male will graze with a herd when it happens to be in its vicinity, and may cover the females when the urge to mate is on it, but withdraws from the herd again when this desire is appeased. When travelling, elephants move in a single file, the leader of the herd being invariably an old female (Fig. 6) while the tuskers generally bring up the rear. Herds travel to and from their feeding grounds by worn paths, wandering from them when the terrain is favourable but returning to the fixed paths which generally follow an easy and straight line across the country and represent probably "the accumulated wisdom of generations of moving elephants". A good site for a *Khedda* will thus be at a place where several elephant paths converge, provided, of course, other facilities like water and feed also exist. When undisturbed, a wild herd pursues a regular and orderly routine drinking and feeding in accustomed places and lying up to rest in its usual retreat. They rest during the hot hours of the day, being intolerant of the sun, feed early in the morning and evening and come out after nightfall to feed in open forest or to raid crops. They sleep after midnight. The afternoon rest is often taken in the standing posture under the shade of a tree, but at night the animal generally sleeps lying on its side, stretching out the legs. The food of the elephant consists of various kinds of grasses and leaves, stems and leaves of wild bamboos and plantains, the bark of some kinds of trees including teak and all kinds of food crops. A full grown elephant may eat about 600 lbs. of green fodder a day. Considerable damage may be caused to young teak planatations lying along the beaten paths of elephants.

Musth in elephants:— On attaining maturity male elephants, both tame and wild, are subject to peculair annual or periodical fits of excitement commonly called *musth*. Very rarely, cow elephants may also get into musth. Musth seems to have some connection with sexual functions and is probably analogous to what we call *heat* in cows and dogs. It occurs more frequently during the cold weather, but in some elephants it may be found at any time of the year; and this condition may also last in some cases for three to four months. It may be due to ungratified sexual desire, but this is not always the cause, because tame tuskers get into *musth* even if the society of the female is at hand, and the condition of *musth* will not be always pacified by allowing a female to associate with a male in *musth*. At other times an elephant in *musth* may seek a mate.

Mating season and young ones etc.— There seems to be no specific mating season in elephants but the young are largely born from November to January or February. The gestation period is said to be 18 to 20 months, varying according to the sex of the calf and being longer for tusker calves. The breeding season is therefore probably in the hot weather, extending into the early south-west monsoon rains. As a general rule only one calf is born at a time though twins and even triplets are stated to have been recorded, the latter, however, only once. The mother of a calf is sometimes assisted in caring for her young by another female who takes on the duties of a guardian, and we therefore often see a young calf running about and suckling from two or even three females. A new-born calf can walk from four to six hours after birth, but it can stand erect immediately after it is born. It will be about 32 to 36 inches in height. The udder of the female, unlike in many other mammals, is at the insertion of the front legs to the body and there are only two hanging teats. The milk is watery in colour. The young one suckles by applying its mouth, and not its trunk, to the teats of the mother. A herd which has new-born sucklings does not move over long distances but generally stays in the same place for a couple of days. When alarmed, the young one takes refuge under its mother's belly.

Elephants have poor sight, with small eyes, and cataract is common in the older animals. The sense of hearing is very highly developed, more so than in most other animals, as is indicated by the large ears. The sense of smell is also equally good.

A daily bath is indispensable to elephants, and they get into water and play about some times for a whole hour, longer during the hot-weather than at other times. Even a just born suckling enters the water along with its mother and, when required it is carried across deep water supported on the trunk of the mother.

At first the young one does not know how to use its trunk for drinking water but takes it direct by its mouth. A full grown elephant takes from 20 to 30 trunkfuls of water, each trunkful holding about 4 to 6 gallons. In hot weather the herd generally goes to water between 2 and 4 P.M., sometimes earlier. Immediately after emerging from a bath, the animal seeks loose earth, picks it up with its trunk and sprinkles it all over its head and back. This toilet it performs very regularly.

Some mystery is attached to the death of elephants. They are stated to seek out a solitary and secluded spot to which they retreat when they feel death approaching. The fact that dead elephants are seldom found in our forests is probably the cause of this legend, but elephants dead by accident or by fighting are not an uncommon find in Mysore forests. One chief reason why we do not find more elephant carcasses is because vultures rapidly consume them.

The tuskers fight for supremacy in a herd and no full grown male generally tolerates another full grown one anywhere close to it. Damage to the tusks from fighting is a common occurrence and, occasionally, death results from the goring incidental to such fights.

In recent years damage to food crops by wild herds has become increasingly common. In 1941, the Deputy Commissioner, Mysore, sent a report to the Government detailing the havoc caused to field crops by wild elephants in the taluks Chamarajanagar, Hunsur and Heggadadevankote. The Chief Conservator, who was consulted in regard to the measures to be taken to prevent the same, sent up to the Government a scheme for meeting the depradations of wild elephants and protecting the food crops during the harvest season. The Government sanctioned the proposals of the Chief Conservator.

This scheme consists in maintaining a special elephant scaring staff of Elephant Supervisors and Elephant Watchers, who are stationed at suitable centres in the taluks Chamarajanagar, Gundlupet, Hunsur, Heggadadevankote and Periyapatna. The primary duty of these men is to gather information about the movements of elephant herds within the territory allotted to their charge, and to organise scaring parties consisting of able bodied villagers and to scare the wild herds out of the cultivated localities in the direction of the nearest forests with the aid of the parties. To enable these men to discharge their duties efficiently and to protect them and their helpers against vicious elephants each party is given a 12 bore double-barrel gun or other suitable fire arm and adequate ammunition. Among the important scaring centres are the following:

Name of Centre	Staff	Taluk.
1. Periyapatna.	One Supervisor & two Watchers.	Periyapatna.
2. Anechowkur.	One Forester & one Watcher.	-do-
3. Nallur pala.	One Forester & three Watchers.	Hunsur.
4. Gurupura.	One Supervisor & four Watchers.	-do-
5. Bheemanahalli.	One Supervisor & two Watchers.	Heggadadevankote.
6. Yedatore. (Kottige).	One Supervisor & two Watchers.	-do-
7. Manchegowdanahalli.	One Game Supervisor & two Watchers.	Heggadadevankote.
8. Laksoge.	One Supervisor & three Watchers.	-do-
9. Moleyur.	One Supervisor & two Watchers.	-do-
10. Nagnapur.	-do-	-do-

11. Begur.	-do-	-do-
12. Maddur.	One Forester & two Watchers.	Gundlupet.
13. Davarahalli.	One Supervisor & two Watchers.	-do-
14. Atgulipura	One Forester & two Watchers.	Chamarajanagar.
15. Karadihalla.	One Supervisor & two Watchers.	-do-
16. Nallur.	One Forester & two Watchers.	-do-

On this small staff has devolved the responsibility of guarding the entire field crop of *mandwa*, rice, jowar etc., over an extensive crop area of about four lakhs of acres scattered in the taluks of Hunsur Periyapatna Heggadadevankote, Nanjangud and Chamarajanagar, against wild elephant herds which roam about unrestricted from place to place and do not hesitate to attack human beings when badly disturbed. It must be stated that, judging from the nature of the work which these men are called upon to do and the courage and pluck which is required for such work, they have done an excellent job for several years by driving away the wild herds time after time into the outlying jungles, which are their natural haunts. The scaring staff also patrol the area within their charge, both by day and night, to locate the positions of the herds, and, aided by a few unwilling villagers, or sometimes even unaided, they dislodge the animals from the thickets where they take shelter during the hot hours of the day and drive them into the forests several miles away where jungle fodder and water are both available for them, so that they may not be forced to return to the crops at night in search of food.

Each party has generally a hundred and fifty to two hundred square miles of territory to protect, so that it is physically impossible for them to do the work which every crop owner is expected to do for himself namely, to keep watch at night and scare a way all wild animals, including of course the elephant, from the immediate vicinity of each and every patch of cultivation. The party can deal generally with elephant erds only.

The system, though excellent in many ways, was found inadequate to meet the greatly increased wave of havoc experienced during certain years.

The chief reasons for this are as follows :—

1. **The inadequate supply of fire arms and ammunition :—**The scaring parties have to dislodge the elephant herds from their resting places during the hot hours of the day and drive them adequately deep into the jungles to prevent their return to the crop-laden fields by night, and this they may be unable to do satisfactorily unless fire arms are available Inadequate supply of shot guns and their ammunition during the war and post-war years became a serious handicap.

2. **The general apathy and callousness of the villager to help in the protection of any field other than his own :—**A cultivator is generally unwilling to go out with the scaring parties to assist in driving away a wild herd unless he sees danger to his own crop. He has to be persuaded to give up this attitude by explaining to him the need for mutual co-operation. Similarly, party feuds and factions in villages sometimes cause splits among the villagers, and men belonging to one party refuse to co-operate in driving the animals from the fields belonging to the opposite side. A spirit of co-operation and mutual toleration and good will among villagers often goes a long way in the successful protection of crops of a whole village or of a whole locality.

Possible measures to strengthen our hands against elephant havoc :—

1. **Organising rural vigilance bodies :-** A vigilance body consisting a dozen able bodied volunteers and containing among them one or two local shikaries should be organised in each village. The shikaries should carry guns and the rest should carry drums and trumpets. The local admistrative officers will probably be able to enlist volunteers for building up such co-operative corps in each village.

2. **Liberal issue of crop-protection arms license to cultivators: —**The lower limit of land revenue paid by an owner which entitles him to a permit for keeping a gun could be reduced so that every person who actually cultivates a patch of land, however small, becomes entitled for the permit. The smaller the holding the more severely does its owner suffer if his crop is invaded by an elephant herd. The existing

rules for the issue permits to keep fire arms enable only the larger land owners to keep guns with them, but the actual cultivator may not get a weapon. In Coorg, for instance, where paddy is grown on an extensive scale and every *Jammi* holder is entitled to a free license for a fire arm, generally a 12-bore breach-loading gun, there is not so much trouble from elephants. Though so many guns exist in the place the elephant population of Coorg does not seem to have dwindled; on the other hand it is stated to be on the increase.

3. **Co-operation of the Revenue and Police Departments with the Forest Department for organising scaring parties of villagers at short notice when an elephant herd approaches the crops in a village :—**Forest subordinates will not generally be in as close touch with the villager as the Revenue subordinates, and are therefore often unable to muster the requisite manpower to drive away a wild herd in times of emergency, nor are they so well versed in the use of firearms as is an average policeman. It is best, therefore, that the three sister departments are made to work together.

4. **Permitting Pit Capture of elephants by land holders.—***Raiyats* who are able to capture elephants by the Pit Method may be permitted to do so and be also given handsome rewards when they effect such captures. Once this is permitted, I think it will be taken up with enthusiasm by at least a few big land holders who can afford to maintain a couple of trained elephants to help in pit-captures. This privilege is enjoyed by certain land owners in Wy-Wynaad and Malabar, and it does not seem to have resulted in undue reduction of elephant population in that area. It may not, therefore, lead to the extermination of elephants from Mysore forests as feared by some people.

5. **Capturing elephant herds by Khedda** :—Frequent *Khedda* captures will go a long way. It is probably advantageous to maintain a permanent nucleus of a *Khedda* department as an adjunct to the Forest Department to enable us to conduct a *Khedda* at short notice and at minimum cost. This permanent khedda staff could be put on elephant scaring work during the crop season, each year. The annual scaring parties consist generally of fresh recruits year after year and it is therefore not always possible to secure the right type of men adequately experienced in this work. A permanent staff will be better able to conduct the scaring work than an annually changing staff.

By applying drastic remedial measures against elephant havoc, we may run the serious risk of unduly reducing the number of this perhaps the finest land animal. Man and his food crops are certainly in need of protection but it would be a thousand pities if his measures of protection are so drastic as to reduce the freedom of living and natural multiplication of this grand animal. Before any drastic remedial measures are applied extensive and coherent forest tracts, where adequate fodder and water facilities exist, should be set apart as "**Elephant Preserves**", and no land should be given out for cultivation within a reasonable distance of such preserves. There should be no relaxation of the law prohibiting the shooting of wild elephants without adequate and effective measures to safeguard the prepetuation of our elephants.

THE PROBLEM OF LAND EROSION AND LANDSLIPS IN THE HOSHIARPUR SIWALIKS*

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Soil erosion and landslips in Northern India as elsewhere in the world are generally believed to be caused by disturbing the original cover of vegetation. Thus, gully erosion and cho formation in the Hoshiarpur Siwaliks have been found by most workers, notably, Gorrie (1938; 41; 46; etc.), Glover (1941; 44; 44a), Coventry (1928), Glover and Hamilton (1935), and Hamilton (1936) to be related singly or collectively to such variable factors as disforestation, excessive grazing and burning of vegetation, high rainfall, steep topography or sandy nature of the rock.

Owing to its great economic importance the problem of erosion has been extensively studied in India as in other parts of the world, and a voluminous literature has accumulated during the last two decades. The menance of *chos* and erosion, in the Siwaliks hills, however, has steadily increased and the area now presents a striking illustration of " deserts on the march ".

Disforestation and destruction of vegetation has occurred in other parts of the country as well. As a matter of fact, the spread of modern towns has gone parallel to the destruction of vegetation in the vicinity and at places where there used to be thick forests there is not a bush left now. Here, although disforestation has been more complete than in some parts of the Siwaliks, erosion of the land has not been the rule. Similarly, the effect of common erosional factors on land has also been not so serious in other areas as in the Siwaliks. In the Siwalik hills the rate and spread of erosion is so great and complete that even a casual observer cannot fail to notice the crumbling of the entire hillside before his very eyes. Surely, there seems to be in the area some other factor, which in combination with disforestation has brought havoc, disturbing the organised agricultural life of the people.

A critical examination of the vast literature in the light of my observations in the Hoshiarpur Siwaliks seems to suggest that none of the external causes usually considered is perhaps singly potent enough to bring about erosion on such a large scale; and it is probable that some internal factor inherent in the structure of the region is fundamentally involved. The present note, therefore, attempts to discover the fundamental factor responsible for soil erosion in these hills and suggest a right method for checking further deterioration of land.

The Siwaliks are a chain of low, much dissected hills running in an east-northwest direction parallel to the Himalayas on its southern side, constituting a foot-hill feature of the lofty ranges to the north. They are composed of alluvial detritus, derived mainly from the inner ranges, such as sand-rock, clays, poorly bedded sand-stones and conglomerates; they are more or less homogeneous along their entire length and are believed to have been deposited contemporareously. Different names have, however, been given to these deposits in different parts of he country. The elevation of the Siwaliks hills varies from 1,500—2,000 feet above sea level. In composition these hills are generally similar in character to recent alluvial deposits, except that they are more compact, having undergone intense folding and faulting by post-tertiary orogenic movements. They generally dip to the south and south-west, and " It is almost certain that the Siwaliks extend down for several miles underneath the alluvial cover of the Indus and Ganges valley " (Krishnan, 1943, p. 468). The Siwaliks at Hoshiarpur are composed of soft and friable sandstones with occasional thin bands of clays and/or conglomerates. The strata of the sandstone dip conspicuously to the south and south-west at high angles.

The Siwaliks, which are now formed of sparsely forested valleys and spurs, probably bore a very luxuriant vegetation in preglacial times, in view of the rich and varied fossil fauna and flora discovered from wide and distant localities in them. The present poor population of plants and animals of this region as a whole

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there I am not referring to the strikingly barren state of Siwaliks which have been disforested in historically recent times) may be due to the inherent ecological changes in the soil and the organisms themselves. It is a well known fact that "The organisms produce vegetational change through their effects upon the environment; and by the production of new forms, varieties, species through evolution. The environment brings about changes in vegetation, because it, too, is undergoing constant change, partly inherent in itself but in part caused by the action of the vegetation upon it" (Cooper, 1926, p. 398). There is ample evidence (Wadia, 1931; 1932; 1936; 1938a; Pascoe, 1919; Pilgrim, 1919; Oldham, 1917, etc.) to show that large scale environmental changes have occurred in Northern India during the (geologically speaking) recent past. For example, changes in the courses of main rivers in the plains in front of the Siwaliks and folding, faulting and thrusts in the Himalayas behind these hills must have produced a great change in the environmental factors in this region. During the Pleistocene period large stretches of north-western Himalayas were glaciated. A cycle of four glacial advances with three intervening interglacial periods has been shown to have occurred in the Kashmir Himalayas (Wadia, 1938; 1940; De Terra and Paterson, 1939). Contemporaneously with the glaciation the Himalayas were uplifted more than once, and these orogenic movements produced considerable effects on the vegetation of the region (Puri, 1947, 1948, 1948a, 1949). At this time conifers invaded our mountains from the west (Sahni, 1931; Puri, 1945, 1947) and constitute now a dominant element in the vegetation of the Himalayas. The Himalayas are still rising, and it is probable that this uplift is further initiating large scale ecological changes not only in the Siwalik hills but also in the whole of Northern India. Almost certainly these would bring about changes in regional climate and determine to a great extent the development of soil and vegetation in local areas. The present phase of erosion in the low-lands below is, therefore, apparently the result of regional changes outlined.

The Siwaliks as a whole dip generally to the south at fairly high angles; it is probable that with the further rise of the Himalayan region interal structure of these hills was so affected as to favour accelerated erosion along the southern dip slopes. There is some evidence from other areas to show that such was probably the case. For example, in the main Himalayas, rise of the land surface rejuvenated rivers and streams giving them an impetus in cutting through the strata of the rocks with greater vigour and force. The comparative intensity of erosion on the southern slopes of the Siwaliks, *vis-a-vis* the northern (on which erosional damage by torrents is little) may, perhaps be due to this factor*.

Thus, it follows that the Siwaliks as a whole are predisposed to severe erosion, which is a consequence of inherent geological activity in the region. The products of erosion contribute towards the building of fresh deposits in front of these foot-hills, which might well form yet another hill in front of the Siwaliks. Grabau (1928) and West (1937) consider that the activity bringing about thrusts in Northern India has been shifting southwards from the Himalayas since Tertiary times, and at present "The locus of activity is along the southern margin of the hills or even further south out in the plains". (West. *loc. cit.*, p. 18). It is highly probable that this migrating geosyncline now operating in the Siwalik hills is instrumental in the slow disappearance of these hills by erosion. The present trend of geological changes at any rate would indicate such a possibility, and "it seems logical to infer that in time the alluvial deposits immediately in front of the Siwalik hills will themselves be folded, thrust faulted and uprised to form yet another range of hills in advance of the Siwalik hills, and yet another accretion to the southern face of the great mountain range" (West, *loc. cit.*). The materials for the formation of such a future range would inevitably come from the erosion of the Siwaliks.

The entire Siwalik hills as compared to other regions in the extra-Peninsular or Peninsular India are geologically predisposed to erosion. But, even then the rate at which the erosion in the Hoshiarpur Siwaliks has proceeded during the last two or three centuries is far greater than that of normal geological erosion. Geological structure and orogenic activity are operating since the very inception of these hills, but the severe phase of erosion hardly dates back to two or at the most three centuries. During this brief period there does not seem to have occurred any perceivable geological change or metamorphism in the structure of the country. It appears, therefore, very likely that this unprecedented scale of erosion has been caused by some external factor which in combination with favourable internal structure has acted as a "trigger" factor. These external factors may be topography, slope, a high rainfall and disforestation.

Of all these external factors topography and slope seem to have little effect in these hills though any one of these may have conceivably locally accelerated the speed of erosion. Discussing the causes of soil erosion in the Siwalik

* Please See Postscript.

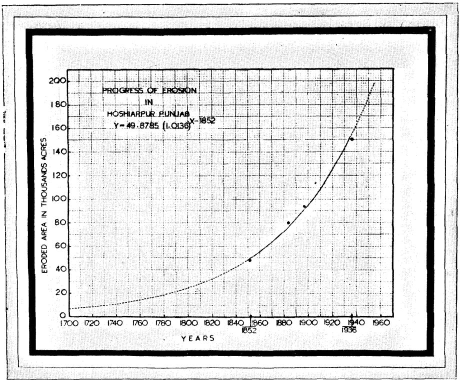
PROGRESS OF EROSION
IN
HOSHIARPUR PUNJAB
Y=49.8785 (1.0136)X-1852
ERODED AREA IN THOUSANDS ACRES
0 20 40 60 80 100 120 140 160 180 200
1700 1720 1740 1760 1780 1800 1820 1840 1860 1880 1900 1920 1940 1960
1852
1936
YEARS

Fig. 1

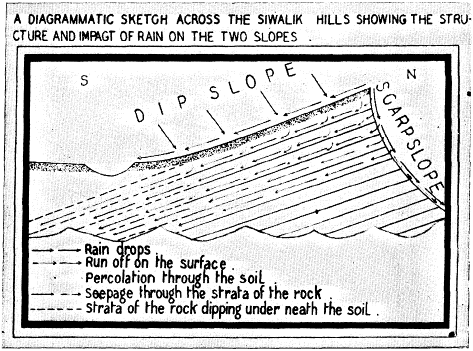
A DIAGRAMMATIC SKETCH ACROSS THE SIWALIK HILLS SHOWING THE STRUCTURE AND IMPACT OF RAIN ON THE TWO SLOPES.
S
DIP SLOPE
N
SCARP SLOPE
Rain drops.
Run off on the surface.
Percolation through the soil.
Seepage through the strata of the rock.
Strata of the rock dipping under neath the soil.

Fig. 2

Hills, Hamilton (1936, p. 10) remarks that "For the most part the Hoshiarpur Siwaliks have a gradual slope from the edge of the plains to the crest, a rise of 600 feet —800 feet in from three to five miles, and externally they appear unlikely to cause serious torrents". That topography and slope are not vital factors in causing land erosion in these hills is evidenced by the fact that the northern slopes, though steeper than the southern, are much less eroded. These observations are in agreement with those of Glover and Hamilton (1935) who stated that on the northern slopes the process of destruction has proceeded more slowly .... (though on these) slopes torrent beds are steeper". The difference in the magnitude of erosion on the northern and southern slopes is, as will be shown below, due to the dip of the strata and the direction of the monsoon winds ; however, it is abundantly clear that steepness of the slope by itself is not the cause of erusion here.

Reasons against a high incidence of rainfall in these hills aggravating soil erosion are apparent from the following facts. During the the years 1862—1930 rainfall has steadily decreased from 36.70—26.61 inches per annum but the areas spoiled by erosion have increased in the same proportion. The following data taken from the report of the year 1943 of the Director, Central Irrigation and Hydranomic Research Station, Poona, are of considerable interest in this connection.*

In 1852 *chos* areas near Hoshiarpur was	48,206 acres.
In 1884 *chos* areas increased to	80,057 acres.
In 1897 *chos* areas increased to	94,236 acres.
† The present area under *chos* is approximately	150,000 acres.

The data for the above four dates have been plotted in Fig. 1 and a smooth curve given by the equation.

$$Y=49.8785\ (1.0136)\ X=1852$$

fitted to them. The fit is reasonably good. Although, it is not advisable to extrapolate such curves, either backward or forward, beyond the observed range of years, namely, 1852-1936, it appears reasonable to conclude that rate of erosion is gathering increased momentum. ‡

Although the amount of rainfall here does not seem to be of much significance in aggravating soil erosion, a consideration of the direction of the rain bearing winds with respect to the general position of the Siwaliks promises to be of considerable interest. Most of the rainfall in these hills is brought about by southern monsoon winds, which strike the southern dip slopes with initial vigour. Much of their force is spent on this side before they reach the northern slopes where owing to lack of strong air currents, due to mountain barriers, the slant of rainfall is more parallel to the hillside than against it. Rain-drops splash is, therefore, reduced on the northern face and in consequence the damage is less. The direction of the rain bearing winds, is thus an important external factor that works in combination with the internal structure of these hills to bring about greater erosion on the southern slopes.

The third and perhaps the most important noticeable factor is of the natural plant cover. There is ample evidence to show that vegetation has been subjected to severe destuction in these hills by man and domesticated animals during the last 100 years. Depending upon the type of soil the removal of tree vegetation has invariably led to the loss of soil fertility, apart from exposing it to the destructive forces of nature. From the point of view of vegetation experience in forestry practices has shown that on poor, sandy soils clearfelling has led to the domination of shrubs and development of more xerophytic type of vegetation. In terms of succession, "the influence of man, however, almost without exception is retrogressive" (Cowles, 1911, p. 179). The other and, perhaps, the most serious effect that clearfelling has on the soil is that it subjects it to the severity of rain-drop splash. The continuous hammering of rain drops on soil poor in humus erodes it away. From the point of view of the development of new vegetation erosion also produces results similar to the biotic factors and "as might be expected, the influence of erosion generally is destructive to vegetation or at least retrogressive (*i.e.* tending to cause departure from the mesophytic") (*loc. cit.*, p. 171). It becomes evident that soil erosion which is inherent in these hills and is accelerated by human influences produces a xerophytic type of vegetation and the activities of man further accelerate this natural trend in vegetational degradation. Human agency is, therefore, largely blamable in this

*Unpublished report is filed under G/261/Gn. of the Ledger files of the Silviculture Branch, F. R. I.
†From Hamilton, 1936, p. 15.
‡I am grateful to Dr. K. R. Nair, Statistician, F. R. I., for his expert help.

case and has played the most ignoble part in this destruction of mother earth. A glance at fig. 1 shows that erosion in its uncontrolable form dates back to the end of the last century—and coincides with the period when the vegetation was severely destroyed under the early British rule. It seems to gain momentum after every passing of a decade ; if nothing is done to check it, it may erase the entire hillside out of existence.

The only remedy against this lies in the binding of the soil by vegetation. Arresting of succession of vegetation when it is in a mesophytic stage may be a solution of checking soil erosion. What may be feasible now may not work after another ten years. Afforestation which is generally considered to be a remedy against erosion may not work at all if it becomes too late. Because the ecological changes in the soil and vegetation are continually working towards xerophytism and it is likely that the planting of xerophytic species—the only ones that can at all be planted under existing conditions—would not produce the desired effect of combating erosion.

It has perhaps already become too late in some places and the futility of afforestation of the kind practised as a measure against erosion in these hills is being felt by such eminent authorities as Glover and Hamilton (*loc. cit.*, p. 65). They observed about 12 years ago that "It is obvious that the usual methods of counter-erosion and reafforestation are impracticable in these hills, as owing to the extreme friability of the sand-rock and the enormous quantities of sand degraded, terracing of the slopes and the training of the small ravines by bunds is impracticable apart from the prohibitive expense". Hamilton (*loc. cit.*, p. 12) further regretted that "The training of *cho* floods in their present state of violence becomes an engineering impossibility, except perhaps, at a fabulous cost". This shows convincingly that erosion in these hills has reached a stage when it cannot be effectively checked by the existing practice of afforestation, and it needs extensive and intensive measures, planned on a strict scientific basis to control soil deterioration.

It, therefore, follows that erosion in the Hoshiarpur Siwaliks is fundamentally the result of general geological activity in the area and the stratigraphy of the rock ***(it has however been aggravated during the last one or two centuries by destructive activities of man in the Hoshiarpur area).*** On this view it becomes easy to explain (1) the relatively greater intensity of erosionon the southern slopes than on the northern, to a sudden rush of water in *chos* after a little rain (3) a gradual lowering of water table in the area, (4) extinction of *chos* after a few miles from these hills and (5) the relatively greater fertility of Jullundur and trans-Jullundur areas.

As it has already been pointed out the strata of the rock in this region generally dip to te south and south-west and form *gullies* and *chos* in the direction of the dip. The northern side of the hills is an escarpment. It will be seen from Fig. 2 that rain-water falling on the northern scarp would seep through the strata to the south, rising to the surface where the rock is fractured or the strata meet the level of the ground.

On account of this structural feature (1) the scarp slop becomes dried sooner even after heavy rain and (2) irrespective of the amount of rainfall at lower parts of the dip slope water would gush through the strata in flood causing severe erosion in the sandy rock. This explanation agrees with the observational data collected in the region by other investigators and may with reasonable accuracy answer the query of Hamilton *viz.*, "The question may be asked how it is that with so slight a gradient the *chos* have been able to acquire sufficient force to do so much damage". It also helps to visualize "the rush of water across the plains has to be seen to be believed" and "the flood subsides as suddenly as it starts and the immense volume of water much of which might have been stored in the hills and sub-soil of the plains, is lost". On account of the friable and porus nature of the sandstones rain-water falling on the dip slopes at once percolates in the sub-soil, where it is subjected to two forces; one taking it downwards, and the other carrying it along the dip of the strata. As a result of this, it produces a shallow horse-shoe shaped frill on the surface the open end of the frill facing towards the dip. This surface frill is widened and deepened into a gully, which cuts back deeply into the strata of the rock as it proceeds. It is, therefore, not surprising that along 80 miles there are more than 100 *chos* which must have originated in the same way.

The Siwaliks hills in other areas are similarly traversed by perennial or semi-perennial torrents along their southern slopes. For example, in a distance of about 50 miles in the Saharanpur division there are as many as 60-70 streams and the number of smaller torrents is much more. The scarp slope in this area is thickly forested and has saved soils along the dip slope from destruction.

On account of the soft and friable nature of the sand-stone in the Hoshiarpur Siwaliks *chos* had branched, ramified and united to form a system

which it is difficult to follow at places. The entire hills are now cut into a chain of spurs and butresses with intervening valleys or *chos* plains. Along the side of some of the larger *chos* the strata of the rock are steeply cut showing clearly their composition and angle of the dip.

At some places where the strata of the sandstone enclose an impervious layer of clays, the entire mass of overlying sandstone, lubricated by seepage waters slips down leaving a gap in the body of the steep-cut side of ravine. It is almost impossible to check these land-slips by planting trees along *chos* or in the flood plains where they grow naturally on freshly deposited silt.

At the upper parts of dip slopes and along bottom of ravines vegetation is farily rich and thick and conditions being favourable for its growth, artificial planting leads to magnificient results. Trees of *Lannea grandis, Dalbergia sissoo, Caesaria tomentosa, Ougeinia dalbergiodes. Bauhinia racemosa, Ehretia laevis, Cassia fistula with shrubs of Hamiltonia sauiveolens, Woodfordia fruticosa and Diospyros tomentosa* were naturally present in such places.

At higher elevations on these hills and on upper parts of the spurs there occurred *Dodonea, viscosa, Adhatoda vasica, Carissa spinarum, Flacourtia ramontchi*, etc. with planted *Acacia* spp. Planting of suitable species in these places would result in still better results.

On most of the spurs which are steep and more resistant to weathering there is relatively little tree vegetation. These probably correspond to scarps. Here *bhabar* grass and *Acacia* spp. were planted, but were not closed to graziers. ***It is here that intensive planting is necessary to checking erosion of the soil.***

Preliminary observations on the vegetation of this area indicate that generally dip slopes at higher elevation and lower levels in numerous valleys bore a better cover of vegetation, and that here a little more effort in planting is necessary to meet local requirements of fuel and fodder. The conditions for natural reproduction, provided there was a controlled and scientific interference from the biotic factor, are favourable.

To check the inflow of water through the strata it would be advantageous if the scarp slope is covered with vegetation. Experience in other areas along the Siwaliks shows that a thick cover of vegetation on the scarp can exercise beneficial effect by utilizing rain water and can to a great degree slow down the rushing in of water through the strata. ***It is, therefore, highly important that large scale and planned afforestation measures be applied on scarp slopes to counteract the erosion.***

SUMMARY.

From the above discussion it follows that the Hoshiarpur Siwalik hills, on account of their structure, composition of the rock and the inherent geological activity in Northern India, are predisposed to erosion and landslips on their southern dip slopes. So a certain amount of erosion normally occurs in these hills. Erosional gullies are formed by the action of rain which percolates in the sub-soil and seeps through the strata issuing on the dip slope with a force depending upon the density of vegetation. A dense vegetation on the scarp slopes and at higher elevations on the dip slope provides a protective cover against the physical and physiological action of rain in accelerating the normal geological erosion. Evidence is re-stated to show that the present state of erosion in the Hoshiarpur Siwaliks was the result of irrational and non-ecological uses (rather misuses) of vegetation, dating back to the last one or two centuries.

While no amount of emphasis is necessary on the value of afforestration to check the erosion it is suggested that (1) a planned and determined programme of planting on scarp slopes and higher elevations on the dip slopes with suitable species be launched without delay; (2) the methods of forest exploitation in other areas in the Siwaliks be carefully examined in the light of ecological data presented in these pages ; (3) extensive and intensive ecological studies of forests be made in the Siwaliks in special regards to soil conservation and spots susceptible to erosion be forthwith tackled by special afforestation parties.

The suggestions made here may be viewed in relation to a paper* submitted by me to the Ministry of Agriculture in June 1947. The need for an organized and intensive ecological research is most urgent for tackling the problem of soil erosion in India now more than it was ten years ago.

* Puri, G. S., (14 June, 1947) " A plea for the establishment of Ecological Survey of India to conduct researches in applied plant ecology in relation to forestry, agriculture and soil conservation ".

A reference may be made to the letter No. F. 42 (3)/48-A dated 25th November, 1948 from the Indian Council of Agricultural Research, New Delhi to the President, F.R.I. Dehra Dun and a copy to me, on this subject.

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Postcripi : Since this paper was sent to the press I requested Dr. J.B. Auden, some-time Director of the Geological Survey of India, Dr. D.N. Wadia and Mr. B.L. Gulatee, President, Survey of India, to give the opinions on the point. They consider my ideas to be interesting and suggest that studies be conducted over larger areas to see if the factor I enumerate is operating in the other areas of the Siwaliks as well. I wish to emphasise the importance of their suggestion and state that my ideas on this point are purely tentative at present.

CONGESTION IN BAMBOO CLUMPS

By Shri R. Chakravarti, Range Officer, Sarangarh, Raigarh Division, Chhattisgarh Circle, C. P.

Reference:—Shri K.L. Lahiri's letter published on page 70 of the INDIAN FORESTER for February '48, Vol. 74, No. 2.

P. N. Deogun in THE SILVICULTURE AND MANAGEMENT OF THE BAMBOO (Indian Forest Records, New Series, Silviculture Vol. II, No. 4) attempts to define congestion as follows:—

"Congestion in its ordinary sense means an overcrowded condition, but in the case of bamboo it means something more. In a congested clump, the culms are not only overcrowded, but at the same time, are held together either by the side branches or by some of the culms interlacing the others in different ways. Badly congested clumps generally have their bases above the ground level and crooked basal portions to the culms."

His above definition does not suggest that congestion is an expresssion of the number of culms in relation to the circumference of the clump. Everywhere, by congestion, one visualises the abnormal conditions detailed by Deogun and it is nowhere suggested that a dense clump need always be congested, or an open clump always "non-congested." Congestion need not also necessarily be brought about by a high degree of density. There may be other factors, most of them biotic.

The term 'congestion' should therefore be restricted to the conditions detailed by Deogun. The number of culms in relation to the circumference of the clump may be denoted by the expression 'density'. The degree of congestion is not easy to arrive at as Lahiri rightly contends; there will always be a certain amount of personal bias. But the cause is good, and the more the exaggeration (of the degree of congestion), the better it is for our bamboo forests.

Deogun also gives a table (on pages 104-5 of the above record) expressing the average density of clumps in Angul and in Hyderabad; and there is no reason why for a given locality, **other conditions being equal**, the density ratio (the number of culms/the circumference of the clump), should not be a constant.

A NOTE ON THE *SUPPLY OF ALTERNATIVE FUEL TO RELEASE CATTLE-DUNG FOR USE AS MANURE IN THE CENTRAL PROVINCES AND BERAR

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SUMMARY

The annual firewood requirement of C.P. & Berar for a populution of 17 millions is estimated at 5,500,000 tons. Total production from Government and private forests and miscellaneous sources is estimated at 2,000,000 tons. Firewood equivalent of charcoal exported is about 6,40,000 tons. The deficit of firewood is about 3,500,000 tons.

Dung produced by about 13,500,000 bovine animals is about 11,000,000 tons (dry) of which 30% is lost in grazing grounds, 30% is used as manure and 40%, *i.e.* 4,400,000 tons (dry) are burnt as fuel. If used as manure this is capable of producing about 4,71,428 tons of extra food grains worth about Rs. 142,000,000/-. The value of firewood equivalent of dung burnt is about Rs. 61,600,000/-.

Shortage is keenly felt in the plains of Chattisgarh, Berar and Nagpur. Forest required to produce the deficit is estimated to be about 8,200 sq. miles. They must be situated closed to villages where supplies are required.

Suggestions for long range arrangements are:—

(i) Creation of firewood plantations by agri-silviculture or line, strip or patch sowing to supplement natural regeneration. Only such methods are considered as feasible from the financial point of view.

(ii) Creation of small wood-lots by villagers through persuasion by propaganda and, if necessary, through legislation later on.

(iii) Planting of single trees or lines of trees along field bunds.

(iv) Planting of road-sides and banks of main canals.

Suggestions for short range arrangements are:—

(i) Prevention of cutting of immature coppice and minimising damage by fires and over-grazing in the scrub-jungle and openly stocked forests.

(ii) Establishment of cheap fuel depots.

(iii) Restriction on export of charcoal and diversion of local surplus to deficit areas.

Pilot schemes are recommended before starting any large schemes for purposes of demonstration and for collection of statistics and gaining experience.

It is worth while investigating the question of improved *choolas* and also the relative merits of charcoal and firewood from the point of view of costs and quantities required per household.

In this note the above subject is dealt with in respect of the province of Central Provinces and Berar as it stood before the integration of States on the Ist January, 1948, the reason being that detailed statistics relating to the former States are not yet available.

2. Firewood and dung-cake are the two important sources of fuel available to the rural population and the latter is also the most readily available manure of excellent quality. The question of release of cattle dung is, therefore , intimately connected with the question of supply of firewood. If the cattle-dung which is now being burnt is to be used for manuring the fields, not only must firewood be made available but it must also be more economical to use it.

3. As everyone interested in rural problems is aware, the matter is rather involved and requires a consideration of several important questions, *e.g.*, the requirement and production of firewood, the production of cattle-dung and estimate of the quantity used as fuel, whether the quantity of firewood equivalent to cattle-dung burnt is available and, if not, whether the same can be produced and made available economically.

4. In the following paragraphs an attempt is made to examine the present position and consider the various possibilities regarding the supply of

* This paper was read at the joint session of the Provincial Compost Conference and the Central Manure Development Committee held at Nagpur in July 1948.
The writer acknowledges the help he has received from Shri K. P. Sagreiya, I.F.S. and Dr. K.G. Joshi in preparing this paper.

alternative fuel in order to release cattle-dung for its proper use as manure.

5. **Requirement of firewood.**—Assuming the average requirement of firewood at 1 seer per person per day, the annual *per capita* requirement is 9 maunds. The total annual requirement of firewood for a population of 17 millions is 153,000,000 maunds or about 5,500,000 tons.

6. **Production of firewood from reserved forests.**—The average production of firewood on sustained basis for a period of five years before the war from about 19,500 square miles of reserved forests was about 34,700,000 cubic feet per year. During the year 1945-46 the production was about 50,000,000 cubic feet. Due to the improvement in the economic conditions and partly due to inflation during the last war it has been possible to extract firewood economically from the remoter areas from where exploitation was not economical before. As pre-war conditions are not expected to return in the near future, it is assumed that it will be possible to extract about 50,000,000 cubic feet of firewood from the reserved forests economically every year. This is by no means the maximum production from the reserved forests. There are fairly extensive areas which are so remote that it will not be possible economically to exploit the firewood yield of those areas unless the tracts are opened up by railways. The firewood available from the reserved forests may, therefore, be taken as 50,000,000 cubic feet or 1,000,000 tons.

7. **Production of firewood from private forests.**—Statistics for the private forests are not available. The total area of zamindari waste land mahals, "tree forests", and "scrub and grass" exceeds the total area of reserved forests. The areas classed as "not available for cultivation" and "out of cultivation" also produce some fuel. The private forests have, however, been over-felled during the last war. In the absence of accurate statistics, the yield of firewood from all these areas may be assumed to be about the same as the yield from the reserved forests.

8. **Total production.**—The total production of firewood is therefore estimated to be about 2,000,000 tons of which 1,000,000 tons are obtained from the reserved forests and the same quanity from private forests and other miscellaneous sources.

9. **Deficit.**—The difference between the estimated requirement (5,500,000 tons) and the estimated available yield (2,000,000 tons) is 3,500,000 tons which represents the deficit. The deficit is likely to increase in future as on the one hand past overfellings in the private forest will reduce the yield and on the other the population of the province is also certain to increase. There is a considerable export of charcoal and firewood, particularly charcoal, out of the province. About 160,000 tons of charcoal alone is being exported. This is equivalent to 640,000 tons of firewood. It is possible that even now the deficit is actually greater than estimated by me. Inspite of the province having a large proportion of its area under forest, the over-all position is that the supply of firewood falls short of the actual requirement. There are large areas in the plains of Chhattisgarh, Nagpur and Berar where either there are no forests or the forest areas are very small. In the greater part of these plains, therefore, firewood shortage is acute. Elsewhere use is restricted on account of high cost. It is therefore not surprising to find that cattle-dung is extensively used as fuel.

10. **Number of bovine animals and yield and use of dung.**—There are about 13,500,000 heads of bovine animals in the Central Provinces and Berar. Assuming that only 5 lb (dry weight) of dung is produced per head per day, the total production of dung is 306,000,000 maunds per year which is equivalent to about 11,000,000 tons. A very large proportion of this is lost in the grazing ground due to the general practice of sending out cattle for grazing. The quantity so lost may easily be 30 per cent of the total. Assuming that another 30 per cent of the dung is utilised as manure, the remainder, *i.e.*, 40 per cent is burnt. The quantity burnt is therefore about 4,400,000 tons dry or 17,600,000 tons of raw-dung. Assuming that one ton of raw dung makes ¾ths. of a ton of farm-yard manure, the manure equivalent of the dung burnt is 13,200,000 tons. Assuming further that 1 ton of farm-yard manure can produce 1 maund of extra foodgrains, the additional quantity of foodgrains which can be produced by utilising the cattle-dung which is burnt, as manure is 471,428 tons. The value of this quantity at the average rate of Rs. 302 per ton (*vide* Central Provinces and Berar Season and Crop Report, 1945-46) is about Rs. 142,400,000. Therefore in terms of food 471,428 tons and in terms of money Rs. 142,400,000, are being lost by the misuse of cattle-dung. The estimated value of firewood equivalent of the dung burnt at Rs. 14 per ton in rural areas is Rs. 61,600,000.

11. **Over-all shortage of fuel.**—The net shortage of firewood in the Province is estimated to be about 3,500,000 tons. The shortage is made

up by burning 4,400,000 tons of cattle-dung. But this dung has to be put into its proper use in the fields. The need for increasing the supplies of firewood, particularly in the plains of Chattisgarh, Berar and Nagpur is, therefore, quite clear. It may be mentioned here that this conclusion is not in accordance with the statement made by Sir Herbert Howard in paragraph 45 of his note on "Post-War Forest Policy for India" that the wants of practically all villagers "are fairly generally and economically supplied". Possibly Sir Herbert Howard was not in a position to examine the question very closely with regard to Central Provinces and Berar.

12. **Forest required to meet the deficit.**—One acre of fully stocked area of forest may be expected to yield about 10 tons of firewood at the age of 15 years. Therefore, to produce 10 tons of firewood on a sustained basis, 15 acres of fully stocked and properly managed forest is required. The total area of forest required to meet the deficit of 3,500,000 tons of firewood on a sustained basis is 5,250,000 acres or about 8,200 square miles. The forests must be fully stocked and properly managed ***and must also be situated close to the villages where the supplies are required***. Assuming the minimum unit of forest area as 500 acres (this area is capable of producing the requirements of two villages of 500 heads each at 1 seer per head per day), the number of forest areas required, each 500 acres in extent, is 10,500. It is advisable to have larger areas than 500 acres at each place for supplying a group of villages. By doing so the costs can be reduced.

13. The data presented above should be enough to dispel any notion, if it exists in any quarter, that the Central Provinces and Berar has no problem of firewood deficiency and misuse of cattle-dung. The firewood problem is acute in the plains of Chhattisgarh, Nagpur and Berar and misuse of cattle-dung is widespread. All that can be said is that this Province is in a better position than the provinces of North India because the population intensity and cattle incidence are lower and there is still a substantially larger proportion of the area under forests in the less developed parts of the Province. There are, however, no extensive coalfields as in Bihar and Bengal. The yield of fuel from the coal-fields of the province is possibly barely sufficient to meet the industrial requirements of the Province and cannot, therefore, be drawn upon for domestic use. The present position must not be allowed to deteriorate and the problem must be attacked before it assumes devastating dimensions as in the Gangetic plains.

14. **Long-range and short-range arrangements.**—Trees take time to grow. Even if firewood plantations are created in suitable areas immediately, the full yield from them will not be available before at least 15 years. The growing of plantations, small wood-lots and single trees cannot, therefore, provide immediate relief and alternative arrangements are necessary for the interim period. Without them the position will deteriorate further during the next two decades. Plantations are, however, the proper and permanent solution of the problem and it is necessary to prepare a scheme and execute the same according to a fixed annual programme. It is obvious, therefore, that the question of supply of alternative fuel concerns both long-range as well as short-range arrangements.

15. **Long range arrangements.**—I shall deal first with the long-range arrangements. Firewood plantations are not necessary for the villages within easy reach of forests—Government or privately owned. It is, however, advisable to pursuade villagers to plant firewood and fodder yielding trees and bamboos along the ***bunds*** of tanks and also below the ***bund*** if the land is not being utilised in any other manner. A planned programme of firewood plantations is necessary for the extensive plains of Chhattisgarh, Berar and Nagpur where shortage is keenly felt. Work should be undertaken in three directions, namely, creation of plantations, formation of small wood-lots and planting of individual trees on the cultivators' holdings.

16. **Creation of plantations.**—It has been stated earlier that 8,200 square miles of plantations are required to make up the shortage of fuel. It is essential to carry out a survey first in the deficit areas to determine exactly where the plantations are needed and to select areas for them. The areas so selected will not as a rule include permanently culturable land. A programme should then be drawn up for a period of 15 years. The area to be planted up annually will be about 550 square miles.

17. **Method.**—Plantations can be created by planting nursery raised seedlings or by direct sowing. The entire area can be sown or planted up or stocking can be done in lines, strips and patches with various modifications. It is needless to mention that if the entire area is not sown or planted, the forest will not be fully stocked in the first rotation but the intervening strips can produce fodder grass during the period of grazing closure and provide grazing when open. Work of any description on the above lines involves considerable expenditure on the formation of plantations

and returns are small until such time as the plantations begin to yield firewood.

18. The method of raising plantations in combination with field crops which is known as agri-silviculture (or *bankheti*) has been practised successfully for many years in various parts of India and elsewhere. The area to be planted or sown is allowed to be cultivated for field crops for a varying period and the cultivators are required to plant up or sow the area with tree species. They also carry out weeding along with the weeding of their crops. This method has the great advantage that plantations are raised without any expenditure, except the cost of the seed, and in many cases substantial revenue is obtained from the leases for cultivation or from the crops if the work is done departmentally. The conditions for success are that the soil must be capable of yielding crops for a few years and there must be land-hunger in the locality. Where the latter condition does not exist but labour is available it may be possible to do the work departmentally.

19. **Cost.**—Ultimately cost will determine the method of work to be adopted. Some data of costs are quoted below. The figures in most cases are taken from papers presented at the Silvicultural Conferences held at the Forest Research Institute, Dehra Dun:—

(i) **Madras**—Sowing on single lines, 1 chain apart, which regenerates one-third of the area ; cost Rs. 2 per acre or Rs. 6 per acre fully stocked.

In lower Godavari division stocking by agri-silvicultural method produced a net revenue of Rs. 7 per acre in the first year. The cost of later tending estimated to be annas 12 to Re. 1 per acre.

(ii) **Mysore**—In Kadur forest division sowing in patches (15 to 20 feet apart) was estimated to cost at least Rs. 2-11-0 per acre.

In the same division, planting of nursery raised seedlings of *Causarina*, *Eucalyptus* and sissoo cost Rs. 30 per acre which included the cost of fencing.

In Kolar forest division sowing in patches (8 to 10 feet apart) was estimated to cost Rs. 6 to Rs. 8 per acre.

(iii) **United Provinces**—Near Bareilly an area of 20 acres was sown and planted with cuttings in patches and holes, 8 feet, 10 feet and 12 feet apart. Costs varied from Rs. 21 to Rs. 50 per acre depending upon the method adopted.

In Jhansi division the cost of raising plantations amounted to as much as Rs. 70 per acre. This was reduced later to Rs. 40 per acre.

(iv) **Gwalior**—The cost of formation was Rs. 30 per acre. The cost of planting in patches with rough fencing was Rs. 18 per acre and without fencing, Rs. 10 per acre.

(v) **Hyderabad**—Including the cost of nursery and establishment, the cost of planting was Rs. 40 per acre.

(vi) **Mysore**—Planting of three miles of canal bank cost Rs. 114. Planting was done in pits.

(vii) **United Provinces**—Sowing in flat land cost Rs. 18 per acre and in ravines Rs. 33 per acre in the first year. Subsequent expenditure was estimated at Rs. 1-8-0 per acre per annum.

The total area of ravine land stocked between 1914 and 1929 was 26,000 acres. The expenditure was Rs. 1-7-0 per acre and the revenue annas 15 per acre. The net deficit was annas 8 per acre. 18,400 acres of *canal Plantation* produced a revenue of Rs. 14-15-0 per acre against an expenditure of Rs. 5-12-0 per acre. The net revenue per acre was Rs. 9-3-0.

(viii) **Central Provinces and Berar**—The following statement shows the up-to-date position of the plantations raised by agri—silvicultural method at Pandhardevi in Yeotmal district:—

	Revenue				Expenditure			
	Rents	Thinning	Grazing	Total	Staff and nursery	Commission to patel	Cleaning and thinning	Total
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Set 1. 1927-32 (7 years lease), area 727 acres.	7,967	2,631	1,530	12,128	1,256	342	453	2,051
Set 2. 1932-39 (7 years lease), area 580 acres.	3,262	4,000	2,072	9,334	1,396	367	397	2,160
Set 3. 1939-46 (7 years lease), area 443 acres.	1,310	735 fire-wood	1,837	3,882	1,426	312	..	1,738
Total				25,344				5,949

A clear profit of Rs.19,395 has been made in raising plantations of 1,750 acres. The average cost of raising the plantations is about Rs. 3-7-0 per acre.

It may be mentioned that in Berar the soil is mostly black cotton soil of fairly good quality which is capable of yielding valuable money crop like cotton.

The latest teak plantations made in Central Provinces and Berar have cost about Rs. 24 per acre in the first year. This does not include the cost of nursery and establishment charges. In one division the cost is only about Rs. 10 per acre.

20. The above data are not comparable because they do not include all items of expenditure in every case and they relate to the pre-war, post-war as well as the war period, but they do indicate that by the agri-silvicultural method, plantations can be raised at a profit and where this method cannot be applied line, strip or patch sowing and planting can be done at a relatively low cost. Full stocking cannot, however, be obtained by line, strip or patch sowing in the first rotation.

21. Assuming that land is available free of cost, and the cost of raising plantations by sowing, including the cost of establishment, etc., will be as low as Rs. 15 per acre, the cost of formation of 550 square miles of forest annually will be Rs. 52,80,000. The raising of fully stocked plantations involving such heavy expenditure, without any returns at the formation stage, may be beyond the financial capacity of this Province. The solution is to employ the agri-silvicultural method. By doing so some extra food or money crops can be raised and the work of sowing and early tending will be done by the cultivators free of cost. Where conditions for agri-silvicultural work are not favourable, artificial work will have to be confined to sowings in lines, strips or patches at low cost to supplement natural regeneration of the selected areas, particularly the scrub jungle and the selected so-called "waste lands".

22. **Choice of species.**—There are quite a number of species from which selection can be made for the different soil conditions which may be met with. A list of the species is given below:—

1. *Cassia siamea.*
2. *Acacia arabica.*
3. *Acacia catechu.*
4. *Azadirachta indica.*
5. *Tectona grandis.*
6. *Albizzia lebbek.*
7. *Albizzia odoratissima.*
8. *Albizzia procera.*
9. *Dalbergia sissoo.*
10. *Prosopis juliflora.*
11. *Prosopis spicigera.*
12. *Pongamia glabra.*
13. *Engenia jambolana.*
14. *Terminalia arjuna.*
15. *Terminalia tomentosa.*
16. *Peltophorum ferrugineum.*
17. *Soymida febrifuga.*
18. *Gmelina arborea.*
19. *Pterocarpus marsupium.*
20. *Cleistanthus collinus.*
21. *Ficus religiosa.*
22. *Zyzyphus jujuba.*

Some of the above species are suitable for particular conditions and types of soil. Therefore a judicious selection and mixture is necessary for each area to be planted.

23. **Small wood-lots.**—Local supply of firewood can be increased to some extent by the creation of small wood-lots in every village by the villagers themselves. Individual cultivators should raise groups of trees in odd bits of their land which is not used for any other purpose or several or all of them may combine to create small wooded patches. In order to get this done mere pursuasion will not be sufficient. But it will also be unwise to apply force abruptly through legislation. The ground should be prepared by propaganda for a few years after which legislation may be introduced.

Even if a third (about 14,000) of the total number of villages of the Province can create about 10 acres of wood-lots each, the total area will be 140,000 acres.

24. **Planting of single trees in holdings:**—In Chhattisgarh plains there is a practice of growing single trees and also lines of several trees along the field bunds. Single trees are allowed to grow even in the rice fields. The most common species is *Acacia arabica.* Other common species noticed are *Terminalia arjuna, Terminalia tomentosa* and *Albizzia procera* Most of the side branches are generally lopped so that the trees do not cast much shade. *Acacia arabica* is found in the fields as well as on the bunds while the other three species are generally found on the bunds only. Assuming on the average only 2 trees per acre of cultivated area, there will be about 13,500,000 trees in the five districts of Chhattisgarh. In terms of fully stocked forest having 400 trees of all sizes per acre, this growth will be equivalent to 33,750 acres of forest. These trees have an important effect in agricultural economy as they provide timber for agricultural implements, a small quantity of firewood and some fodder.

The effect of growing trees in this manner on the crops is not clearly known as far as I am

aware. If such growth does not affect the crops adversely to an appreciable extent, it is worth while extending the practice on a systematic basis wherever possible.

25. **Road-side and canal bank planting.**—Before leaving the long term arrangements, I would like also to mention the planting up of the road-sides and canal banks. The area available will be up to 2 to 3 acres per running mile of road and main canals. Only a small proportion of the total length supports tree growth at present. There is scope for increasing the local supplies of agricultural timber, firewood and fodder by afforesting these areas with a carefully selected mixture of species. There is apparently nothing to prevent the Public Works and Irrigation Departments from going ahead with this work and there is no reason why these areas should not be developed. If a cheap method of sowing is adopted, costs can be kept low and the work will ultimately be profitable. In the United Provinces the canal bank plantations have produced substantial profits.

26. **Short-range arrangements.**—Long-range arrangements based upon creation of plantations will not have any appreciable effect on firewood supply before at least 15 years. To prevent further deterioration in the present position it is necessary to adopt immediately measures to provide the maximum quantity of firewood or charcoal economically to the deficit areas. By preventing ruthless cutting of immature coppice shoots and minimising the damage done by fires and over-grazing, production can be stimulated in the scrub jungle and openly stocked forest within a few years. For immediate increase in firewood supply the remedy is to restrict export outside the Province and to divert the local surplus production in certain parts to the fuel starved areas in the Province itself. Another remedy is to arrange for the supply of firewood and charcoal at low rates from depots established at suitable places all over the deficit areas.

27. **Fuel depots.**—Fuel should be supplied from these depots at prices which will just cover all costs plus a nominal royalty. Such a scheme can be adopted only in respect of the firewood obtainable from the Government owned forests. The remoter areas from where firewood is not extracted at present should be worked for this scheme. If areas which are under working now are required to supply these depots there will be shortage elsewhere.

28. The introduction of such a scheme will have to be preceded by propaganda in the villages concerned to educate the people in the economics of cattle-dung **versus** firewood. ***The people must be convinced that by using the dung as manure not only crop production is increased substantially, but the value of the extra crop is also considerably more than the cost of firewood that they may have to buy for burning to replace cattle-dung as fuel.***

29. With people hard up for cash the urge for using dung as fuel must be very strong because no payment has to be made for it, whereas even if cheap firewood is supplied some cash has to be found to pay for it periodically. Here possibly, co-operation will be found to be useful. The dung could be collected from individuals into common manure pits and firewood advanced against it. The total manure could be distributed when required in proportion to the contributions made by individuals and the value of fire wood recovered after the crops are harvested.

30. **Operation of the depots.**—There are various difficulties in operating a scheme of this nature. To prevent misuse of the concession by villagers and traders, sales from the depots will have to be retail sales of specified quantities for *bona-fide* domestic requirements (and not for sale or barter) on weekly or fortnightly permits to be held by individual house-holders. It may not be feasible for the Forest Department to run such retail sale depots in villages situated far away from the forests and an independent agency may have to be created for the purpose. This agency will deal direct with individual villagers or village co-operatives where these exist.

31. **Pilot schemes.**—So far I have dealt with mainly the theoretical aspects of the problem and have attempted to indicate the directions in which work can be undertaken. In practice, before starting on large schemes, it is advisable to start Pilot Schemes for purposes of demonstration and for collecting statistics and gaining experience. This done, the results obtained should be given wide publicity. The final comprehensive schemes will have to be based on reliable surveys and the estimates of costs and returns will have to be based on the experience gained from the pilot schemes.

32. **Improved Choolas.**—As regards improved *choolas*, I trust this matter will be dealt with by those who are competent to do so. In this connection it is worth while investigating the claims made for the smokeless "HERL" *choola* which is recommended by Dr. S.P. Raju of the Hyderabad Engineering Research Laboratories.

I also consider that the relative merits of the use of charcoal and firewood from the point of view of costs and quantities required per household are worth investigating. If it is found to be convenient as well as economical to use charcoal, the problem of transport will probably be somewhat easier. Charcoal is about half in volume and quarter in weight of the wood from which it is converted.

ARAKU VALLEY STETTLEMENT

By P. V. C. RAO

"Soil Conservationist"

The Araku valley lies in the hinterland of the Vizagapatam district amidst the bowels of the eastern ghats. After a run of about 40 miles from Vizagapatam along the planis, the road takes a tortuous route over the mountainous tracts climbing to an apex of about 5000 feet at Anantagiri and a steep descent of about 2500 feet till the valley commences at about the 65th mile. Over these precipitous mountains there are thick forests belonging to the Vizianagaram and Jeypore estates. Forest fires often take a heavy tole of these reserves which are not maintained well. The valley forests are completely cleared by the hill tribes who are accustomed to *Podu* cultivation by burning the hill slopes. This practice has been in vouge since generations. The valley consists of a basin of undulating topography with bare hills, gentle slopes and numerous mountain streams.

The 3000 feet agency plateau on the hinterland of the Vizagapatam district consists of about three lakhs of acres of which nearly two and half lakhs of acres are heavily denuded due to the shifting cultivation. It gets an average rainfall of about 50 inches with heavy thunder showers during August and September. The soil is rich red loam, and the hill tribes grow a variety of dry crops. Paddy is grown on terraced mountain stream beds.

The burning type of cultivation of bare hill-sides and the stream side slopes, coupled with the heavy rainfall, has been devastating the valley through the menacing process of soil erosion. It has been shown by experiments in America that a single storm erodes a burnt hillside to the tune of 110 tons of soil per acre. It is therefore no wonder that millions of tons of soil are being carried away every year by the mountain streams through the invidious process of soil erosion. The valley's main river is the Machkund which takes in a number of swift flowing streams cutting their way through precipitous hills. The river and its tributaries are always found to be heavily charged with silt. The swift currents carry massive boulders during floods which often take a heavy toll of life of men and cattle.

Road laying in such a difficult terrain is an expensive job as it necessitates the construction of numerous bridges across the streams. The only motarable road in this region is the one from Vizagapatam to Jeypore of 140 miles in length. The steep ascent and descent covers about 25 miles and the valley starts after about 65 miles from Vizagapatam. The road becomes inaccessible during the flood season between June and October. A telegraph line connects the Araku settlement with Vizagapatam. There are a few mud roads connecting the interior villages which generally consist of not more than a dozen hutments for each group.

The hill tribes consist of a number of castes and clans. Their condition has recently been investigated by a Committee appointed by the Madras Government. Their civilization is primitive, and the majority of them do not know the use of the peasant's plough and bullock. For their number, the magnitude of the damage done by these tribes to the six lakhs of acres of land of the Vizagapatam and Koraput Zamindari agency tracts is amazingly collossal. Some of the bared hills still hold rich and deep red loamy soil which cover the valley land to an abundent measure. If timely steps are taken to prevent any further destruction, it will be possible to save this soil from further runoff.

With a view to reclaiming the valley and utilizing the same for agricultural settlements of plains men, the Government of Madras introduced the Araku Valley Scheme in 1944 over an experimental area of about 8,000 acres. Agricultural Farms were set in, and communications in the settlement area were improved. Anti-malarial operations rendered the place healthy. Liberal grants which include subvensions

from Central Government were being provided for rendering the settlement a success, but unfortunately as more experience was gained the faith in the efficacy of the project began to fade out. The organization has slowly been whittled down keeping only the nucleus of the essential staff.

The reason for lack of the anticipated measure of success is not far to seek. The agricultural operations are not attuned to the requirements of the typical topography of the valley. As no flow irrigation is possible, the age-long dry-farming practices have been set up. No attempts have been made to arrest the run-off and erosion which are the natural legacies of heavy downpours on uncovered and undulating lands. The value of the combined operations of engineering, forestry and agriculture is not realized. No systematic afforestation of the barren hill slopes has been undertaken. We know the result of the destructive type of dry-farming practices in vogue for generations in the arid zones like the Ceded Districts of he Deccan plateau. We cannot achieve anything sepectacular by following similar practices in a heavy humid zone like the Araku valley. On the other hand, the heavy precipitation renders the erosional damage far more severe than that ordinarily experienced in arid areas.

The remedy obviously lies in a scrupulous adaptation of "Conservation Farming" method of agricultural development. Regular afforestation of all slopes exceeding 10 per cent in gradient through graded contour trenches and drainage ways should be undertaken. Slopes less than 10 per cent in gradient should be provided with drainage type of contour terraces. Gully erosion and bank cutting should be arrested. These mechanical methods must be associated with improved methods of dry farming including contour cultivation and strip-cropping. With this type of "natural irrigation," it should be possible to cultivate all irrigated and dry crops.

When once the agricultural economy is built up on sound foundations it should not be difficult to induce rapid rural settlement of the region through co-operative farming. Instead of taking up barren lands in arid districts for reclamation, we can get speedier results if this rich valley of about two lakhs of acres with its abundant rainfall is taken up immediately for bold development on the basis of a well-planned five year programme.

The Araku valley forms part of the 860 square mile catchment of the Machkund river whose waters are now being tapped for a major hydro-electric project. The Machkund Project is expected to satisfy the electricity requirements of the coastal districts of the Andhra Desa and also the Koraput and Ganjam districts of the Orissa Province. The waters of this river are now heavily charged with silt which could seriously jeopardize the longevity of the project. It is therefore imperative that the continuous flow of the erosional debris washed down the hill slopes into the river and its tributaries should be effectively checked. Towards this end, it is worth while examining seriously the feasibility of integrating the agricultural and forestry development of the valley with the hydro-electric scheme, so that the development of the valley and its waters may be conceived as a multipurpose project. The benefits that will accrue from such a conception are really immense. The hinterland of the Vizagapatam and Koraput districts consisting of about five lakhs of acres will be developed for agricultural settlements and increased food production. At the same time the Machkund hydro-electric project will be saved from the horror of sedimentation. With a broad and bold vision of approach, it will be easy to achieve quick results.

EXTRACTS

PASTURES AND FORAGE CROPS IN THE TROPICSS.

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(*from* " *World Crops.* ")

Of recent years great advances have been made in pasture management and the cultivation of forage crops in temperate countries, and the range of materials and of methods which can be employed is well understood. Under tropical conditions the matter is equally important, but many of the controlling factors differ considerably from those in temperate regions, and methods have to be evolved which suit the altered conditions. Progress at present lags behind what has been achieved in temperate climates, although knowledge is growing.

It is necessary to adopt a restricted meaning of the term ' pasture ' as applied to tropical conditions if this discussion is to have any shape within its allotted scope. The word ' pasture' has become too widely used for conditions very different from those of Western Europe where it originated. The Oxford Dictionary defines it as herbage for cattle, or a ' piece of land covered with this '. It is doubtful if a European would accept a 6-ft. high stand of elephant grass as a pasture, although it does provide herbage for cattle.

For the purpose of this article, its scope will be restricted to those areas of land on which herbage plants are cultivated for grazing, soiling or other use, or to those areas which may be termed grazing grounds and which approximate to the European idea of a pasture. We will therefore discuss intensive ' pasture ' management and disregard for the moment those extensive areas of grassland, savannah, desert scrub and other associations which provide sustenance for livestock, and which require to be managed according to ecological principles.

The best fodder crops for the tropics appear at the moment to be the tall, erect perennial grasses to which pasture management on the British pattern cannot be applied. The average yield of green forage from cultivated tropical grasses under good conditions should be double or treble that which is usually obtained from a good grass ley in England. The nutritive value of tropical herbage at its best is distinctly lower than that of young English pasture herbage, but the total yield of digestible nutrients per acre must be considerably higher due to the longer growing season.

GRAZING VERSUS SOILING.

Pasturing represents the cheapest method of providing animal fodder, obviating as it does the carting of fodder to the stall and of manure from the stall. Under certain economic and climatic conditions in the tropics, however, the cutting and carting of green herbage daily for feeding to stock at the steading is preferred. Both methods have their respective uses. Soiling is especillay applicable where land is short or where grade dairy cattle are the main class of livestock, as these require protection against the hot tropical sun. The grazing technique is generally preferable for the rearing and development of healthy stud animals and young stock and for the economical production of beef cattle.

Only some few of the tropical grasses, such as *Panicum maximum*, *Brachiaria mutica*, or *Melinis minutiflora*, can stand anything approaching heavy grazing without damage, and this depends again upon the grazing habits of different classes of livestock. It would appear to be desirable to work out some combination of grazing and soiling for particular conditions, governed by the type of livestock, the nature of the herbage, seasonal availability of fodder and so on. Systems of grazing with appropriate rest periods will also have to be evolved.

SHADE ON PASTURE.

The inclusion of shade trees on pastures may serve a number of purposes. They may merely provide shade for the livestock in the heat of the day; they may, if members of the Leguminosae, help to provide a better protein balance for the livestock, if browsing and pollarding are permitted or the foliage might be fed on the soiling system.

Recent observations in Malaya have indicated an even more important function. Grass growing under the shade of rain trees (*Enterolobium saman*), with their wide-spreading

not-too-dense canopies, is of stronger growth and better quality than grass growing in situations exposed to the sun. Mountain shade provides ideal conditions for growth of carpet grass (*Axonopus compressus*). When conditions are sufficiently favourable, this vigorous stoloniferous grass is able to suppress or supersede coarser grasses, including even *Imperata cylindrica* if cut and grazed. It may therefore be an advantage to plant grazing grounds with fairly widely spaced suitable shade trees, preferably leguminous.

There are also preliminary data to indicate that the protein content of *Axonopus compressus* is higher under leguminous trees (14.32%) than under other trees or oil palms (10.92%) or in the open (9.68%).

The white clover of tropical pastures may therefore be a tree.

GRASS SPECIES.

The classfication of tropical pasture grasses proposed by D.D. Paterson provides a useful basis:

(a) Pasture or turf-forming species, comprising the more important bottom grasses capable of forming a more or less dense, close, fursward:

Savannah or carpet grass (*Axonopus compressus.*)

Bahama or devil or doob grass (*Cynodon dactylon*).

Pimento or buffalo grass (*Stenotaphrum secundatum*).

Centipede grass (*Eremochloa ophiuroides*).
Java grass (*Polytrias praemorsa*).

(b) Trailing species which do not form turf but produce a thick tangled cover 1 to 3 ft. in depth composed of a profusion of intertwined leafy runners:

Para or Mauritius grass (*Brachiaria mutica*).

Molasses or Wynné grass (*Melinis minutiflora*).

Seymour or Barbados sour grass (*Andropogon pertusus, Amphilophis sp.?*)

Star grass (*Cynodon plectostachyum*).

(c) Tufted or stool forming species, mainly tall, erect cane-like grasses:

Elephant grass (*Pennisetum purpureum*).

Guatemala grass (*Tripsacum laxum*).

Guinea grass (*Panicum maximum*).

Uba or other thin sugar-cane (*Saccharum sinense*).

These lists do not include at least two of the important grasses of East Africa, Rhodes grass (*Chloris gayana*) and kikuyu (*Pennisetum clandestinum*), and new grasses are constantly appearing IN THE LITERATURE AS AN INDICATION OF RESERVES IN THE NATURAL FLORAS as yet untapped. From West Africa one heard reference some time ago to *Andropogon gayanus* and *Pennisetum pedicellatum*.

Not many of the tropical grasses have yet been the subject of even of mass selection for production of improved strains. Kenya has its Nzoia Rhodes grass, Uganda and Hawaii strains of elephant grass resistant to *Helminthosporium*, but this branch of research is in its infancy. One feels that it may yet be preferable to test more genera and species rather than to embark on expensive breeding programmes.

There is also the problem that many of the tropical grasses produce little or no seed and have to be reproduced vegetatively. As labour costs increase, this will become a decided disadvantage and a study of causes of this deficiency will be desirable.

LEGUMINOUS SPECIES.

The tropics are outside the range of tolerance of lucerne and the true pasture clover, and the search for a leguminous species which will form a stable association with the tropical grasses is one of the most difficult in tropical pasture research. Legumes are desirable in order to improve the protein content of the herbage and to provide nitrogen in the soil for the benefit of associated grasses and other species. None of the species so far tried appear to have the necessary climatic adaptation, or the necessary growth form, to permit them to withstand grazing and cutting or to thrive in competition with tall grass species. In Trinidad, for example, legumes from other tropical counties, including species of *Alysicarpus*, *Lespedeza*, *Stylosanthes* and *Pueraria*, have been tried but only *Stylosanthes*—the so-called Townsville lucerne—shows any promise.

In Trinidad also it has been possible to obtain a fai r cover of the following more or less perennial legumes: *Centrosema pubescens*, *Calopogonium muco noides* , *Dolichos hosei*, *Indigofera endecaphyll a* and *Pueraria javanica*. All require some six to twelve months to develop a satisfactory mat and afterwards require very careful manament and periodic hand-weeding to prevent them from being smothered and killed by the dominant weeds of the locality. The species of *Indigogera* has been reported to be the most promising, particularly under the conditions obtaining in the island of Puerto Rico.

For these reasons it may be necessary to adopt methods of incorporating legumes in the pastures which are quite different from those common in temperate lands. The inclusion of leguminous trees and shrubs as shade trees, hedges or windbreaks has been suggested; the tropical floras appear to be rich in such plants, for example species of *Erythrina* , *Gliricida*, *Leucaena*, *Albizzia* and *Prosopis*.

There are, of course many annual or short-term leguminous forage and cover crops which may be grown on ultivated land in the tropics, such as *Mucuna aterrima*, *Delichos lablab*, *Vigna unguiculata*, *Phaseolus mungo* and *Cajanus cajan*. These are, however, relatively expensive to grow, limited and variable in their yield of green fodder, and have to compete for land space with a food crop which may be of greater immediate value to the cultivator. Further, if they are grown for their grain, they cannot be regarded as ideal soil-improving crops in a crop rotation.

The problem of the pasture legume is therefore of primary importance under humid tropical conditions, first to discover whether it is really desirable and feasible to emulate humid temperate pastures in this respect and, if so, to test all available species for adaptation to the climatic and biotic environment concerned.

CONSERVATION OF FODDER

Although the growing season of humid tropical pasture may be said to be generally longer than that in humid temperate countries there are nevertheless, periods when the productivity of pasture species may be low and conserved fodder in the form of hay or silage is required. Under most humid tropical conditions, the flush of growth which might be conserved occurs during the wet season when the making of hay would be difficult if not impossible. There are a number of reports of successful silage-making under tropical conditions, and there appears to be no reason why further research on this method of consevation should not show that it is generally applicable. Problems may arise because of the lowr initial protein content of herbage to be ensiled, and possibly also because of variations in keeping quality under tropical conditions.

A number of enquiries have been received at the Bureau of Pastures and Field Crops concerning the value of artificial drying in tropical conditions. Officers have, for example, been concerned at the great loss of potential fodder which is produced by the flush of seasonal growth in tropical grasslands, but which cannot be harvested or grazed. It has been suggested that a portable drier burning wood fuel might be the answer. It must, however, be pointed out that the artificial drying of grass is economic in humid temperate lands such as Great Britain when the legume or grass is cut at an early stage of growth and a high protein content can be obtained. It would appear theoretically to be difficult so to time the movement and operation of a portable drier in tropical grass areas that the herbage was always cut at an appropriate growth stage. The generally low protein content of tropical herbage is another factor to be considered.

It is therefore suggested that, although grass-drying may be possible under certain conditions in the tropics, research might with greater advantage be devoted to the conservation of flushes of growth in the form of silage, in order that methods can be evolved for the use of agricultural instructors and advisers.

CHEMICAL COMPOSITION AND NUTRITIVE VALUE

Animals in the tropics may have to eat very large amounts of fodder in order to obtain their nutrient requirements. When elephant grass in Trinidad was compared with pasturage in England on a monthly cropping rotation, even the least mature cuts of elephant grass gave a very low protein percentage. The more rapid growth of the tropical fodder appears to produce a much quicker drop in the protein percentage, so as to make it impossible to obtain from elephant grass a fodder with a close nutrition ratio. In an insular tropical climate as obtains in the West Indies, the rainfall incidence is the seasonal factor which has most influence on plant growth. A definite correlation exists between monthly precipitation and composition of herbage. The dry matter, crude protein and ash percentage all vary inversely with the rainfall. In the wet months there is a fall in the percentage of these three constituents.

On the other hand, the crude fibre percentage tends to increase during the wet season. As the poductivity of elephant grass is at its highest in the heavy rainfall months, this seasonal fluctuation in compositon of the grass means that when the crop is growing most vigorously the nutritive value per unit weight of herbage is at its lowest.

Any evaluation of the tropical grass species must obviously be based on total yield, under an appropriate grazing or cutting system, and seasonal chemical compositions of the herbage. Under Trinidad conditions, for example, elephant grass has proved a failure due to its susceptibility to disease, and Guatemala grass (*Tripsacum laxum*) has demonstrated its superiority as a silage crop. Elephant grass is, however, one of the most popular tropical fodders, and the new strains resistant to *Helminthosporium* being developed in Hawaii and elsewhere may be of great economic value.

Work on the mineral content of tropical grasses is also desirable, as there are indications that some species such as *Melinis minutiflora* are lower than others in mineral content, although they may appear to be promising from other aspects.

ALTERNATE HUSBANDRY.

Interest is at present widespread in the various types of resting breaks which may be incorporated into farming systems to give the soil a rest from a period of continuous arable cropping and to acquire renewed fertility in terms of soil structure or other character. In a broad sense and as applied to tropical conditions, alternate husbandry can be regarded as covering everything from a grazed bush or grass fallow in shifting cultivation to a true crop rotation partly composed of a pure or mixed herbage stand for grazing, or for feeding in a stall or yard with complete transfer of manure to the land.

Striking evidence of the effects of a temporary ley on soil structure and resistence to erosion has been obtained by Dr. W.S. Martin and his collaborators while working in Uganda. Soil which had been cropped continuously for seven years received greater benefit (expressed in yield of subsequent cotton crop) after a period under a cover of *Pennisetum purpureum* than after the legume, *Centrosema pubescens*. If the period of arable cultivation has not been too long, natural regeneration of a complete cover of the grass may be achieved in six months. Under Ceylon conditions, a three-year period of grass fallow under the same grass is suggested even though this means that an appreciable part of a holding will no be producing economic crops during this period.

Some of the main factors concerned in the development of the temporary resting or grazing ley in the Colonial Empire are, (a) the degree to which the cultivators are willing or can economically afford to take the long-term view and sacrifice immediate return from cash crops for a method of maintaining fertility, (b) the capacity for natural regeneraton of a suitable resting herbage of the availability for planting or sowing of suitable species, which do not have characters undesirable when the ground is next to be ploughed, (c) the availability, when grazing or animal feeding is to be adopted, to obtain an economic return from the resting period of suitable animals to utilise the fodder provided, and of a market for the animal products, and (d) the absence of controlling factors such as tsetse fly, religious customs, cereal diets, and so on.

The main characteristics required of a grass for temporary leys under tropical conditions are: (a) ability to form a complete cover rapidly, (b) at least moderate persistence under heavy grazing if need be, (c) ease of eradication of tufts or root systems when it becomes necessary to revert to arable cropping, and (d) availability of planting material in the form of a commercial seed supply. Under Kenya conditions, for example, Rhodes grass is suitable for the purpose , whereas kikuyu grass (*Pennisetum clandestinum*) has the undesirable features of being strictly limited by its climatic requirements and of possessing a system of strong rhizomes, making eradication difficult. It is furthermore difficult to obtain seed from many of the potentially valuable tropical grasses.

FODDER SUPPLY AND ANIMAL HUSBANDRY

In conclusion it is desriable to stress that improvements in source and type of animal fodder have to be made alongside parallel improvements in the capacity of the livestock to utilise that fodder and to provide a maximum economic return on the higher costs involved. If developments in these two directions are properly balanced and integrated, it will be found tha they can play an important part in a system of land use on a sustained yiel: basis, dependent upon optimal conservation of soil and water, and the maintenance of fertility.

PERMAPLY

(from " Wood ")

A plywood in which the wood plies are said to be equal in durability to the resin bond is now being marketed under the name " Permaply " by Venesta Ltd., Vintry House, Queen St. Place, London, E.C.4. During the course of manufacture the plies are so treated that they are effectively protected from moisture, dryness and heat, and so become, it is claimed, impervious to climatic conditions.

Permaply can be used for facing and roofing buildings, on the outside of vehicles, for signboards, etc. and in any climate, even without the application of a coat of paint. It is said to be resistant to rot, and also to white and beetle attack, points of vital importance for tropical use.

LICHENS IN A SUBURBAN STREET.

(From " The Victorian Naturalist")

How long does it take for lichens to clothe the rocks in soil? In Ludstone Street (off Hampton Street), Hampton, is a strip of concrete path twenty years old. Nine inches of it, on the north side, near the fence, is untrodden. It remained bare until the last four years or so. Now there is a continuous film of lichen. In dry weather, it is black grey. Nobody would suspect any life there. With one shower, however, the whole strip is transformed. Green, grey, yellow and orange patches flash out to take advantage of conditions while they last. No mosses have appeared. Probably the film, with accumulated blown soil, is one thirty-second of an inch thick.

There is a galvanized iron fence at one part. Not a sign of lichem appears in its shade. Presumably, enough of zinc comes down with the rain to inhibit growth. There is, however, a green scum of algae.

A.J.S.

HERE ARE SOME OF THE TREES THAT MADE HISTORY.

(From " Forest and Outdoor")

Unfortunately, history has a way—at least in Canada—of getting buried and forgotten. Yet the story of our trees and the important part they have contributed to a dozen phases of our past and present history and economy is so interesting that it should be familiar to every school child.

But to make history as exciting as fiction requires not only a knowledge of the subject on the part of the author, but also a high degree of writing ability which too few historians possess. Yet when a talented writer tackles Canadian history both adults and children find it intensely absorbing. Gohn Fisher, a CBC commentator, gave four broadcasts last winter which for all time spiked the rumor that Canadians weren't interested in their country's history.

In this case the subject were two children's books: Children's Book of the Suguenay and Children's Book of the Great Lakes. Said Fisher in essence: " *It's about time someone* else besides author Leonard L. Knott took an interest in telling our children about Canada's glorious history. " Entitled simply: " Don't leave it to Leonard ", the programs outpulled every other similar type of broadcast which the CBC had conducted.

The publishers of the foregoing books—Editorial Associates Limited —were deluged with mail from parents, librarians and other groups suggesting that it would be appreciated if further books on Canada and things Canadian were published.

With this thought in mind the publishers started work on similar books. The latest is The Children's Book of Trees which was also written by Mr. Knott. Here is a random quote from the book which gives an idea of the interesting style in which it is written:

" A forest is really a city of trees. A big forest is just like Montreal or Toronto.... becuase trees are like people....they eat and sleep and breathe and when they are cut or bruised or break a limb they are sometimes visited by a tree doctor. They live together in family groups and they have many different family names....like people, trees have a history......though little trees never go to school to learn it. They have taken part in many wars, have helped build cities and schools and hospitals. They have a much more exciting history than most people imagine. "

The Children's Book of Trees is based on authentic information supplied by the Canadian Forestry Association, and in addiion to the text there is more than a score of colored illustrations by the renowned Canadian artist,

Jacques Gagnier. The Winnipeg-born writer and the Quebec-born artist have colaborated on all three books to produce outstanding successes.

Ganier, like Knott, has a unique ability to give a life-like dramatic quality to his work, so that even the drawings are in themselves a liberal education for the juvenile reader.

In the Children's Book of Trees there are four pages which conain illustrations and text pertaining to the principle trees of Canada. These studies alone will open up an entirely new field of interest to the young reader who in future will take a keen delight in trying to classify every tree he sees. And by the time he reaches adult age he will be a booster for our forest lands and will do much to halt the current spread of unnecessary destruction—especially that which is caused by carelessness and ignorance.

One point of interest is that through the support of the Canadian Forestry Association the price of this well-bound hard cover book has been kept at a dollar, with a reduction in price for quantity orders.

The Children's Book of Trees is now meeting such a ready acceptance everywhere that it will soon find itself on the best selling lists of children's books.

RESULTS OF CONTROLLED BURNING IN THE SAL PLANTATIONS OF BENGAL

By A. S. Rawat, Head Computor, F. R. I.

SUMMARY

(*1*) *Change in the undergrowth.*

After the first few years of burning, there were clear indications of the evergreen undergrowth, such as ferns and Piper *spp., getting reduced, and it was expected that the annual burning would eventually eradicate these species, especially* Pollinia ciliata (*sau grass*) *which prevents the establishment of sal, and that* Imperata arundinacea (*thatch*) *would replace* Pollinia; *but the incidence of the thatch is small and it is replacing the* sau *grass in openings only. After about 15 years of annual burning, most of the evergreen species still persisted. Burning did not lessen the number of climbers, nor did it kill them. They remained more or less the same in the burnt and unburnt plots, though slightly less luxuriant in the former.*

(*2*) *Cost of Climber cutting.*

Only in the case of Buxa division was the cost of climber cutting significantly less for the burnt plots compared to the unburnt ones. This significant reduction in the cost may be due to the mechanical advantage of the cleaner ground in the burnt plots which makes it easier to the labour to work in them.

(*3*) *Rate of growth and volume increment of sal.*

Controlled burning did not produce any beneficial effect on the diameter and height increment of sal; in some cases it has rather produced, with regard to diameter, the reverse effect. On this evidence we may therefore state that burning is setting back the diameter development of sal plantations in Bengal to some extent. It makes the soil drier which perhaps leads to reduction in the rate af sal growth but height growth has remained unaffected. The present technique of clearfelling the climax forest, burning the debris and planting sal are perhaps responsible for the establishment and good growth of sal in the moist soils of the Bengal plantations.

The question of controlled burning in the sal plantation in Bengal has been engaging the attention of the officers concerned with the management of sal forests for a long time. In 1915, as in the case of the Kamrup division, Assam started controlled burning of all areas which could be so treated. But in Bengal, the conditions being quite different from those of Assam, this method could not be adopted in its entirety. Owing to moister conditions prevailing here, evergreen species had taken hold of the soil and hence burning was considered impracticable. Some other method of regenerating the sal areas, therefore, had to be thought of and this has led to the current technique of clearfelling the natural forest and planting sal. The growth of plantation sal in Bengal is fast and there is little delay in its establishment (Fig. 1).

Sal is not the climax formation in Bengal. Like a surgical operation therefore, the climax forest is clearfelled, burnt and sown with sal. The ecological balance is thus suddenly upset at the time of plantation formation, but later on the existing conditions are not interfered with. Thus the ecological retrogression brought in for propagating sal remains perhaps for a short time and then returns to normal conditions. Generally speaking, the existing conditions are quite favourable for plant growth. It is thus natural that if sal could be made to establish itself under such conditions, it would grow extremely well. This explains the good growth of plantation sal in Bengal.

Burning is a method of checking or reversing the ecological progression. It makes the soil drier, resulting, perhaps, in checking the rate of growth of sal. This fact has been corroborated by the results obtained from the experimental plots under study in this paper.

Bengal produces one of the best kinds of sal but some officers still doubt if moist soil is actually good for sal or whether making it drier by annual burning is better and more useful in inducing natural sal regeneration. The sets of burnt and unburnt experimental plots shown in Table 1, were, therefore, laid out in various divisions of the Northern Circle of Bengal with the object of comparing the effect of controlled burning on plantation sal with regards to:

(1) the condition of undergrowth,

(2) cost of climber cutting, and

TABLE

Experimental plots in different

Forest Division	Range	Locality and year of sal plantation	E.P. Nos.
Buxa	Rajabhatkhawa	1922 Rajabhatkhawa sal plantation	14A, 14B, 14C
Buxa	Chilapata	1922 North Mendabari sal plantation	17 & 18
Buxa	Rajabhatkhawa	1925 Nimati sal plantation	21 & 22
Jalpaiguri	Moraghat	1924 sal plantation of Dalgaon	8 & 9
Kalimpong	Tista	1923 sal plantation of Bhalukhop block	1 & 2
Kurseong	Bagdogra	1924 sal plantation of Kadma	5 & 6

1

Divisions, Northern Circle, Bengal.

Indicator Nos. burnt or unburnt	Year of formation	Final year of measurement	REMARKS.
I.P. No. 1 in E.P. No. 14A—annually burnt	1929 (April)	1945 (November)	
I.P. No. 2 in E.P. No. 14B—control to I.P. No. 1	do.	do.	
I.P. No. 3 in E.P. No. 14B — control to I.P. No. 4	do.	do.	
I.P. No. 4 in E.P. No. 14C — biennially burnt	do.	do.	
17A burnt and 18A unburnt	1931 (March)	1947 (February)	
21A burnt 22A unburnt	1932 (February)	1945 (December)	
8A unburnt 9A burnt	1932 (January)	1947 (February)	
1A burnt 2A unburnt	1930 (December)	1946 (December)	
5A unburnt 6A burnt	1930 (December)	1944 (October)	

(3) rate of growth and volume increment of sal.

(1) *Change and general condition of undergrowth.*

Before the burning was started, the under growth consisted of ferns, *Piper* spp., *Pollinia-ciliata*, *Clerodendron infortunatum*, *Coffea bengalensis*, *Leea* spp., *Melastoma* sp., *Ficus hispida*, *Flemmingia spp.* etc. (Fig 2.) After a few years of burning, there were clear indications of the evergreen undergrowth *i.e.*, ferns and *Piper* spp., being reduced every year and it was hoped that within a few years these would be completely eradicated. It was also expected that repeated annual burning would eventually eradicate *Pollinia ciliata* which prevents the establishment of sal, and thatch would replace *Pollinia ciliata* (*sau* grass); but the incidence of *Imperata arundinacea* is small and it is replacing *sau* grass in openings only. After about 15 years annual burning, most of these species still persist in the burnt area, although they are lighter and less luxuriant than in the unburnt plots.

The principal climbers, before burning, consisted of *Milletia auriculata*, *Mimosa pinnata*, *Tinospora cordifolia*, *Piper longum*, *Smilax* spp., *Vitis* spp., *Spatholobus roxburghii* etc. in all the plots. Burning could not kill these climbers and so the same species persisted in both the burnt and unburnt areas being much less luxuriant in the former.

As a result of burning Experimental plot Nos. 14A (annually) and 14C (biennially), Buxa division, the evergreens began to disappear and *sau* grass and *Ageratum conyzoides* occupied the plots. This continued for a few years only and later, thatch and *Eupatorium odoratum* spread almost over the whole of the burnt plots (Fig. 3.)

In the other plots of the same division (E.P. Nos. 17, 17A, 18, 18A, 21, 21A and 22, 22A), after the first few years of annual burning, evergreen species gradually changed to the dry type and finally, after about 12 years of annual burning, *Coffea bengalensis*, *Clerodendron infortunatum*, *Morinda* spp., *Urena lobata*, *Leea* sp., *Terminalia belerica*, a few ferns and some grasses occupied the burnt plots. The same species existed in the control plots but there they were more luxuriant and more frequent. In the case of the Mendabari experimental plot it is worth noting that thatch is appearing where heavy evergreens like *Botapan* existed before.

In the case of Experimental Plot Nos. 8, 8A (control) and 9, 9A (burnt), Jalpaiguri division, the same undergrowth continued for some years, but, as a result of repeated annual burning for 15 years, it became lighter, and later on thatch and *Ageratum conyzoides* occupied the burnt plot. Coppice shoots of sal formed the second storey in both the burnt and unburnt plots.

In Experimental Plot Nos. 1, 1A (burnt) and 2, 2A (control) of Kalimpong division, the evergreen species persisted inspite of the annual burning, for about six years after the creation of the plots, after which evergreen undergrowth became lighter. In the unburnt plot, the undergrowth continued to be denser and more luxuriant than in the burnt plot throughout the period of burning from 1930 to 1947.

In case of Experimental Plot No. 6, 6A of Kurseong division, the evergreen species persisted for 4 years of the annual burning, when they became lighter and gave way to the drier types. Ferns and creepers almost disappeared and thatch and *Saccharum* spp., spread over the whole plot. Nine years of the creation of these plots, as a result of too hot a fire, epicormic branches increased in the whole burnt plot. In 1941 *i.e.*, after 12 years of annual burning, *Panicum* spp. and thatch occupied the whole of the burnt plot; then the former began to suppress the latter. The condition of sal was good in both the burnt and unburnt plots. Climbers were less luxuriant in the burnt area.

For want of adequate recorded data on the condition of the undergrowth from year to year, no statistical analysis has been possible and so this item has been disposed off as an observational study only.

(2) *Cost of climber cutting.*

The cost of climber cutting per acre has been collected for each sub-plot. In a few cases, it has not been recorded for some years. Such years have been ignored, and the cost has been taken as nil for those years when no climber cutting was done.

Only in the case of the Buxa division, the cost of climber cutting was found significantly less for the burnt plots than the unburnt ones. For Jalpaiguri, Kalimpong and Kurseong divisions, the mean cost per acre did not differ significantly.

It has been generally admitted that the ground fires do not and cannot kill climbers.

Fig. 1

Sal forest of very good quality just thinned. Average diameter 11.8″, average height 100′, Stems per acre 156, age 66 years. Total Volume (after thinning) 4601 c. ft. per acre. Jalpaiguri Divn., Bengal.

Fig. 2

Shorea robusta, upper *bhabar* sal forest with dense *sau* grass (*Pollinia ciliata*), *Clerodendron infortunatum*, *Mallotus*, and *Mucuna pruriens* climbing *Sterculia villosa*. Buxa division, Bengal. Photo H.G. Champion

Fig. 3.

Shorea robusta, 1920 plantation showing the flush of epicormics consequent on controlled burning in 1931, Buxa division, Bengal. Photo H.G. Champion 1932.

If climbers happen to get burnt, root suckers spring up from their root stocks and these grow and again climb up the tree in a short time. The significant reduction in the cost of climber cutting in Buxa division, may therefore be chiefly due to the mechanical advantage of the cleaner ground which provides facilities to the labour.

(3) *Rate of growth and volume increment of Sal.*

(a) Sample plot method of comparison.

According to the present practice of comparing sample plot results Tables 2 to 8 have been prepared in which have been given the number of stems per acre, the crop diameter, the basal area per acre and the top height of the main crop for different years of measurements for 7 sets of burnt and unburnt experimental plots. As laid down on page 225 of the Silvicultural Research Manual Vol. II 'Statistical Code' by Champion and Mahendru, for initial comparison of plots, basal area, number of stems and crop height should not differ by more than 10%, 20% and 15% respectively.

On this basis, we find that for Experimental Plot Nos. 14A, 14B, and 14C, Buxa division (Tables 2 & 3), the percentage difference compared to the control plot, did not exceed the permissible limits in 1929. But, from 1937 onwards, basal area per acre for the control plot (Table 2), exceeded 10% although the number of stems per acre did not exceed the acceptable limit (*i.e.* 20%). In Table 3, we find that at the beginning of the experiment the difference was in favour of the plot to be burnt, but the crop diameter became negative by 1933 and the crop basal area also became negative by 1940. This shows that burning had an adverse effect on the development of sal.

In case of Experimental Plot Nos. 17, 17A (burnt) and 18, 18A (control) of the same division the initial difference in basal area per acre was higher by 57% but as a result of the annual burnings, the basal area came down to 16% in 1935 and still later, in 1947, became only 2%, inspite of the fact that the number of stems per acre remained throughout higher and also almost constant. This clearly shows that the thinning, which was carried out to the same intensity in both the plots, had no direct bearing on the above change. This adverse effect on the basal area can perhaps be attributed to burning alone.

From Table 5, we find that in 1932, the number of stems per acre in the burnt plot was greater by 30% and basal area by 6.9%, but in 1937, the percentage of difference in the number of stems between the two plots, was zero and the basal area was actually less than in the unburnt plot by 26.9%. Again, in 1941, inspite of the existence of 28% more of stems in the burnt plot the basal area is less by 3.4%, and this figure increased to 4.3% in 1945. Thus even in these plots it is quite clear that burning did not produce any beneficial effect on the growth of sal, but the effect was actually unfavourable.

Now, comparing the growth figures of Experimental Plot Nos. 5, 5A (control) and 6, 6A (burnt) of Kurseong division (Table 6) we find that at the start, in 1930, the plots were not comparable as regards basal area and height, which were higher in the plots to be burnt by 18.1% and 18.5% respectively. As a result of the annual burnings for 5 years, these differences came down to 8.6% and 2.3% respectively, but then the percentage difference in the number of stems per acre went up to 22 in the burnt plot. In other words, in the burnt plots, with the increase in the basal area the number of stems also increased, and as a matter of fact the burnt plot remained inferior to the control plot throughout. We cannot therefore assert that the annual burning has produced either beneficial or adverse effects on the growth of sal in this particular case.

We get similar results from Table 7. In the start *i.e.*, in 1930, only the basal area exceeded the acceptable limit of 10%. With the increase in basal area, the number of stems in the burnt plot increased in 1937 and exceeded 20% in 1941. In this case also, we cannot say that burning was entirely responsible for this change.

The plots of Jalpaiguri division, (Table 8), were quite comparable in 1932, and up to 1941 we do not find any appreciable difference in the burnt and unburnt areas; but in 1947 the percentage difference in basal area was greater in the unburnt plot compared to the burnt one by 11.8. In this case, there is a clear indication that burning has had an adverse effect on diameter growth.

(b) Statistical method of comparison.

On analysing and comparing the mean diameters of the standing crops before and after the thinnings in the burnt and unburnt sub plots of Experimental Plot Nos. 14A, 14B and 14 C (Tables 9 & 10), we do not find any significant difference between them for any year except 1937.

TABLE

Comparison of I.P. No. 1 of E.P. No. 14A (annually

Year of measurement	I.P. No. 1 (annually burnt)				I.P. No. 2	
	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)
April 1929 ..	1152	2.6	43.5	26	1176	2.6
March 1933 ..	1008	3.7	75.4	41	1080	3.6
January 1937 ..	284	5.3	44.2	52	296	5.9
January 1940 ..	224	6.6	53.3	..	268	7.0
December 1942 ..	216	7.7	68.8	..	248	7.8
November 1945 ..	212	8.3	78.9	..	236	8.5

TABLE

Comparison of I.P. No. 3 of E.P. No. 14B (control) and I.P. No. 4

Year of measurement	I.P. No. 3 (control)				I.P. No. 4	
	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)
April 1929 ..	1000	2.4	32.7	26	1092	2.5
March 1933 ..	904	3.7	66.6	42	940	3.6
January 1937 ..	244	5.9	45.9	52	292	5.6
January 1940 ..	228	7.0	61.6	..	236	6.8
December 1942 ..	212	7.8	70.9	..	212	7.7
November 1945 ..	196	8.6	78.7	..	200	8.5

2

burnt) and I.P. No. 2 of E.P. No. 14B (control) Buxa division, Bengal.

(control)		% difference				REMARKS
Basal area per acre sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	
43.7	26	2.0	0	−0.5	0	% difference calculated on the basis of the control plot.
76.5	42	6.7	+2.8	−1.4	−2.4	
55.4	52	4.1	−10.2	−20.2	0	
70.6	..	16.4	−5.7	−24.5		
81.7	..	12.9	1.3	−15.8		
92.0	..	10.2	−2.4	−14.2		

3

of E.P. No. 14C (biennially burnt) Buxa division, Bengal.

(biennially burnt)		% difference				Remarks
Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	
36.1	26	+8.4	+4.0	+9.4	0	% difference calculated on the basis of the control plot.
68.1	41	+3.8	−2.8	+2.2	+2.4	
49.3	53	+16.4	−5.4	+6.9	+1.9	
58.7	..	+3.4	−2.9	−4.9		
68.1	..	0	−1.3	−4.1		
78.3	..	+2.0	−1.2	−0.5		

TABLE

Comparison of E.P. Nos. 17A (burnt)

Year of measurement	Condition	E.P. No. 17A (burnt)				
		Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre
March 1931	Initial	3194	1.9	64.2	28	2798
November 1935	After thinning	657	3.4	40.5	36	572
January 1941	Unthinned	645	4.5	70.2	..	565
February 1945	Unthinned	621	5.1	86.5	58	556
February 1947	After thinning*	419	5.4	66.5	59	375

TABLE

Comparison of E.P. Nos. 21A (burnt) and 22A

Year of measurement	E.P. No. 21A (burnt)				E.P. No. 22A	
	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)
February 1932 (Main) ..	2222	2.0	46.6	26	1706	2.2
January 1937 (Main) ..	367	4.3	36.5	42	367	5.0
December 1941 (Main) ..	290	6.0	57.7	57	226	7.0
December 1945 (Main) ..	258	7.2	73.9	72	202	8.4

4

and 18A (unburnt), Buxa division, Bengal.

E. P. No. 18A (unburnt)			% difference*				
Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	REMARKS.
1.6	40.8	26	+14	+19	+57	+8	% difference is calculated on the basis of the unburnt plot figures.
3.4	34.9	37	+15	0	+16	−3	
4.8	70.9	..	+14	−6	−1	..	
5.4	87.6	61	+12	−6	−1	−5	
5.6	65.1	63	+12	−4	+2	−6	

*Main crop.

5

(control), Buxa division, Bengal.

(control)		% difference*				
Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	REMARKS.
43.6	27	+30	−9.1	+6.9	−3.7	* % difference is calculated on the basis of the unburnt plot figures.
49.9	45	0	−14.0	−26.9	−6.7	
59.7	58	+28	−14.3	−3.4	−1.7	
77.2	78	+28	−14.3	−4.3	−7.7	

TABLE

Comparison of E.P. Nos. 5A (unburnt) and 6A

Year of measurement	E.P. No. 5A (unburnt) Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	E.P. No. 6A Number of stems per acre	Crop diameter (inches)
November 1930 ..	2923	1.8	51.5	32	2669	1.7
January 1936 ..	617	3.7	45.7	45	508	3.9
February 1941 ..	617	4.8	78.0	..	504	4.9
October 1944 ..	536	5.2	80.7	..	456	5.4

TABLE

Comparison of E.P. No. 1A (burnt) and

Year of Measurement	E.P. No. 1A (burnt) Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	E.P. No. 2A Number of stems per acre	Crop diameter (inches)
December 1930 ..	1073	2.6	40.4	30	1093	2.8
April 1937 ..	387	4.7	45.5	50	331	5.0
November 1941 ..	234	6.5	54.2	..	177	7.1
December 1946 ..	206	7.6	64.3	76	153	8.4

TABLE

Comparison of E.P. No. 8A (control) and 9A

Year of measurement	E.P. No. 8A (control) Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq ft.)	Top height (ft.)	E.P. No. 9A Number of stems per acre	Crop diameter (inches)
January 1932 ..	1440	2.9	65.4	37	1435	2.8
January 1937 ..	206	5.1	29.1	52	218	5.0
November 1941 ..	177	7.7	57.9	..	190	7.2
February 1947 ..	145	9.4	70.2	84	157	8.5

6

(burnt), Kurseong division, Bengal.

(burnt)		% difference *				REMARKS
Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	
43.6	27	-10	-5.9	-18.1	-18.5	* % difference is calculated on the basis of the unburnt plot figures.
42.1	44	-22	+5.1	-8.6	-2.3	
67.0	..	-22	+2.0	-16.4	..	
72.7	62	-18	+3.7	-11.0	..	

7

E.P. No. 2A (control), Kalimpong division, Bengal.

(control)		% difference				REMARKS
Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height ft.)	
46.2	30	-2	-7.1	-12.6	0	% differences calculated on the basis of the control plot.
44.3	51	+17	-6.0	+2.7	-2.0	
49.3	..	+32	-8.5	+9.9	..	
61.0	80	+35	-9.5	+5.4	-5.0	

8

(burnt), Jalpaiguri division, Bengal.

(burnt)		% difference				REMARKS
Basal area per acre (sq. ft.)	Top height (ft.)	Number of stems per acre	Crop diameter (inches)	Basal area per acre (sq. ft.)	Top height (ft.)	
60.4	38	0	-3.4	-7.6	+2.7	% differences calculated on the basis of the control plot.
30.1	49	+6	-2.0	+3.4	-5.8	
53.4	..	+7	-6.5	-7.8	..	
61.9	76	+8	-9.6	-11.8	-9.5	

TABLE 9

Effect of annual burning on diameter of sal, Buxa Division, Bengal.

Sub-plot No. and treatment	14A Annually burnt		14B Control		Difference of diameters (1–2) with its standard error (Diff. ± its S.E.)
Indicator plot No.	1		2		
Date of measurement (month and year)	Number of stems (n)	Mean diameter with standard error of the mean ($\bar{d} \pm$ S.E.)	Number of stems (n)	Mean diameter with standard error of the mean ($\bar{d} \pm$ S.E.)	
April 1929	291	2.49 ± 0.043	294	2.46 ± 0.046	0.03 ± .063
March 1933 (before thinning)	266	3.54 ± 0.068	282	3.44 ± 0.070	0.10 ± .097
March 1933 (after thinning)	252	3.54 ± 0.071	270	3.43 ± 0.073	0.11 ± .101
January 1937 (before thinning)	192	4.27 ± 0.101	232	4.29 ± 0.105	−0.02 ± .147
January 1937 (after thinning)	71	5.32 ± 0.140	74	5.82 ± 0.131	−0.50 ± .191
January 1940	56	6.45 ± 0.179	67	6.76 ± 0.151	−0.31 ± .232
December 1942	54	7.32 ± 0.228	62	7.54 ± 0.189	−0.22 ± .293
November 1945	53	7.97 ± 0.270	59	8.22 ± 0.219	−0.25 ± .344

TABLE 10

Effect of biennial burning on diameter of sal, Buxa division, Bengal.

Sub-plot No. and treatment	14B Control		14C Biennially burnt		Difference of diameters (4–3) with its standard error (Diff. ± its S.E.)
Indicator plot No.	3		4		
Date of measurement (month and year)	Number of stems (n)	Mean diameter with standard error of the mean ($\bar{d} \pm$ S.E.)	Number of stems (n)	Mean diameter with standard error of the mean ($\bar{d} \pm$ S.E.)	
April 1929	252	2.32 ± 0.048	275	2.30 ± 0.047	−0.02 ± .067
March 1933 (before thinning)	241	3.47 ± 0.076	258	3.47 ± 0.071	0 ± .104
March 1933 (after thinning)	226	3.48 ± 0.081	235	3.46 ± 0.076	−0.02 ± .110
January 1937 (before thinning)	194	4.43 ± 0.111	187	4.31 ± 0.108	−0.12 ± .155
January 1937 (after thinning)	61	5.84 ± 0.136	73	5.54 ± 0.114	−0.30 ± .175
January 1940	57	6.83 ± 0.169	59	6.47 ± 0.173	−0.36 ± .241
December 1942	53	7.59 ± 0.210	53	7.39 ± 0.231	−0.20 ± .312
November 1945	49	8.30 ± 0.264	50	8.22 ± 0.268	−0.08 ± .376

TABLE 11

Effect of burning on diameter of sal, Buxa division, Bengal.

Sub-plot No. and treatment		E.P. No. 17A (Burnt)		E.P. No. 18A (Control)		
Date of measurement (month and year)	Condition	Number of stems (n)	Mean diameter ± S.E.	Number of stems (n)	Mean diameter ± S.E.	Difference in mean diameter ± S.E.
March 1931	Initial	800	1.77 ± 0.023	738	1.44 ± 0.023	0.33 ± 0.033
November 1935	Before thinning	662	2.30 ± 0.032	680	2.13 ± 0.035	0.17 ± 0.048
	After thinning	491	2.17 ± 0.040	568	2.00 ± 0.039	0.17 ± 0.056
January 1941	No thinning done	160	4.24 ± 0.068	140	4.65 ± 0.070	-0.41 ± 0.098
January 1945	No thinning done	154	4.84 ± 0.090	138	5.17 ± 0.092	-0.33 ± 0.129
February 1947	Before thinning	154	4.94 ± 0.098	138	5.24 ± 0.100	-0.30 ± 0.140
	After thinning	105	5.20 ± 0.121	93	5.48 ± 0.127	-0.28 ± 0.175

TABLE 12

Effect of burning on diameter of sal, Buxa division, Bengal.

Sub-plot No. and treatment		E.P. No. 21A (Burnt)		E.P. No. 22A (Control)		
Date of measurement (month and year)	Condition	Number of stems (n)	Mean diameter ±S.E.	Number of stems (n)	Mean diameter ±S.E.	Difference in mean diameter ±S.E.
February 1932	Before thinning	876	1.39 ± 0.028	530	1.70 ± 0.040	-0.31 ± 0.047
	After thinning	561	1.78 ± 0.031	432	1.94 ± 0.040	-0.16 ± 0.049
January 1937	Before thinning	390	2.86 ± 0.051	404	2.93 ± 0.073	-0.07 ± 0.089
	After thinning	91	4.09 ± 0.085	91	4.80 ± 0.099	-0.71 ± 0.130
December 1941	Before thinning	89	5.58 ± 0.128	91	6.23 ± 0.148	-0.65 ± 0.196
	After thinning	72	5.78 ± 0.138	56	6.73 ± 0.161	-0.95 ± 0.212
December 1945	Before thinning	69	6.98 ± 0.186	53	8.13 ± 0.213	-1.15 ± 0.282
	After thinning	65	7.03 ± 0.191	50	8.20 ± 0.224	-1.17 ± 0.294

TABLE 13

Effect of burning on diameter, Jalpaiguri division, Bengal.

Sub-plot No. and treatment	8A (Control)		9A (Burnt)		Difference of diameters (9A–8A) and its standard error (Diff. ± S.E.)
Date of measurement (month and year)	Number of stems (n)	Mean diameter and its standard error ($\bar{d}$ ± S.E.)	Number of stems (n)	Mean diameter and its standard error ($\bar{d}$ ± S.E.)	
January 1932 (before thinning)	381	2.68 ± 0.039	479	2.39 ± 0.039	− 0.29 ± 0.056
January 1932 (after thinning)	357	2.73 ± 0.039	356	2.58 ± 0.044	− 0.15 ± 0.059
January 1937 (before thinning)	355	3.60 ± 0.072	318	3.60 ± 0.078	0 ± 0.106
January 1937 (after thinning)	51	4.91 ± 0.171	54	4.90 ± 0.127	− 0.01 ± 0.212
November 1941 (before thinning)	46	7.36 ± 0.207	48	6.97 ± 0.174	− 0.39 ± 0.269
November 1941 (after thinning)	44	7.49 ± 0.193	47	6.99 ± 0.176	− 0.50 ± 0.260
February 1947 (before thinning)	43	9.06 ± 0.268	47	7.80 ± 0.221	− 1.26 ± 0.345
February 1947 (after thinning)	36	9.18 ± 0.302	39	8.22 ± 0.275	− 0.96 ± 0.407

TABLE 14

Effect of burning on diameter, Kalimpong division, Bengal.

Sub-plot No. and treatment	1A (Burnt)		2A (Control)		Difference of diameters (1A–2A) and its standard error (Diff. ± S.E.)
Date of measurement (month and year)	Number of stems (n)	Mean diameter and its standard error ($\bar{d} \pm$S.E.)	Number of stems (n)	Mean diameter and its standard error ($\bar{d} \pm$S.E.)	
December 1930 (before thinning)	326	2.41 ± 0.032	380	2.50 ± 0.032	-0.09 ± 0.045
December 1930 (after thinning)	266	2.50 ± 0.036	271	2.65 ± 0.038	-0.15 ± 0.052
April 1937 (before thinning)	248	3.82 ± 0.068	262	3.91 ± 0.070	-0.09 ± 0.098
April 1937 (after thinning)	96	4.48 ± 0.078	82	4.85 ± 0.094	-0.37 ± 0.121
November 1941 (before thinning)	96	5.82 ± 0.117	82	6.23 ± 0.138	-0.41 ± 0.180
November 1941 (after thinning)	58	6.38 ± 0.132	44	6.93 ± 0.155	-0.55 ± 0.203
December 1946 (before thinning)	58	7.34 ± 0.172	43	8.28 ± 0.220	-0.94 ± 0.275
December 1946 (after thinning)	51	7.35 ± 0.188	38	8.32 ± 0.232	-0.97 ± 0.295

TABLE 15

Effect of annual burning on height of sal, Buxa division, Bengal.

Date of measurement	Burnt (E.P. No. 14A) 1		Control (E.P. No. 14B) 2		Difference in mean height ± S.E.
	Number of stems	Mean height (ft.)	Number of stems	Mean height (ft.)	(ft.)
April 1929	12	22.96	12	20.58	2.38±1.753
March 1933	11	30.36	12	31.42	—1.06±3.569
January 1940	6	55.17	7	55.29	—0.12±2.838
December 1942	6	63.50	6	62.83	0.67±3.227
November 1945	6	68.33	6	66.75	1.58±3.345

NOTE : For want of adequate standing sample trees, 1937 heights could not be compared.

TABLE 16

Effect of biennial burning on height of sal, Buxa division, Bengal.

Date of measurement	Control (E.P. No. 14B) 3		Biennually burnt (E.P.14C) 4		Difference in mean height ±S.E.
	Number of stems	Mean height (ft.)	Number of stems	Mean height (ft.)	(ft.)
April 1929	12	18.67	12	17.90	—0.77±2.258
March 1933	12	28.75	11	30.73	1.98±3.963
January 1940	6	56.33	6	60.83	4.50±4.634
December 1942	6	61.33	6	64.58	3.25±3.204
November 1945	6	68.42	6	68.75	0.33±4.367

TABLE 17

Effect of burning on height of Sal, Jalpaiguri division, Bengal.

Date of measurement	E.P. No. 8A (Control)		E.P. No. 9A (Burnt)		Difference in mean height ±S.E (ft.)
	Number of stems	Mean height (ft.)	Number of stems	Mean height (ft.)	
November 1941	5	57.60	6	52.17	—5.43±3.426
February 1947	6	75.00	6	62.50	—12.50±7.745

TABLE 18

Effect of burning on height of Sal, Kalimpong division, Bengal.

Date of measurement	E.P. No. 1A (Burnt)		E.P. No. 2A (Control)		Difference in mean height ±S.E. (ft.)
	Number of stems	Mean height (ft.)	Number of stems	Mean height (ft.)	
December 1946	6	69.00	6	67.33	1.67±5.714

TABLE 19

Effect of burning on height of Sal, Buxa division, Bengal.

Date of measurement	E.P. No. 17A (Burnt)		E.P. No. 18A (Control)		Difference in height ±S.E. (ft.)
	Number of stems	Mean height (ft.)	Number of stems	Mean height (ft.)	
January 1941	7	39.00	7	42.00	—3.00±5.529
February 1945	8	47.50	7	47.86	—0.36±6.780
February 1947	6	51.83	6	54.17	—2.34±7.509

In case of Experimental Plot Nos. 17A (burnt) and 18A (unburnt), Table 11, the mean diameter of the former was significantly higher than the latter in 1931 and this continued upto 1935 before and after thinning; but from 1941 onwards up to 1947 (before thinning) we find the mean diameter of the control plot significantly better than that of the burnt plot which gives a definite indication that burning has produced a significantly adverse effect on diameter growth.

On examining the results of Experimental Plot Nos. 21A (burnt) and 22A (unburnt) of the same division (Table 12), we find that the mean diameter of the burnt plot remained significantly inferior to the mean diameter of the control plot except in 1937 (before thinning), and the burning did not prove beneficial to sal development.

In case of Jalpaiguri and Kalimpong plots also, the burnt plots were initially significantly inferior to the control plots and the same situation continued up to the last when they were finally measured.

The standing height data recorded at the time of each remeasurement are inadequate. Moreover the same trees were not measured for height. According to the existing sample plot practice heights of only 6-12 standing sample trees have been measured by selection. As most of the felled sample trees were taken from outside the plots, their heights have not been accepted for statistical analysis. However, on comparing only the means of the standing heights of the burnt and unburnt plots, no significant difference was found in any case for any year. It is, therefore, evident that the burning has had no effect on the height increment of sal.

Since volume figures directly depend on diameter and height and are derived graphically by height-form factor method, there is no use analysing statistically such derived data.

I am grateful to the Central Silviculturist for having permitted me to make use of the data incorporated above.

SANDAL FORESTS IN COORG

By K. M. Nanayya

Just as teak in Burma and deodar in the Himalayas so Sandal is the *Royal tree* in Coorg. We know that sandal is the most valuable marketable produce from Southern India as it is an important commodity of world-commerce. Its great value lies in its oil, which is extracted by steam distillation. This oil finds extensive use as an article of commerce in the manufacture of soap, perfumes and drugs. The wood is used, to a limited extent, for funeral pyres, festive and religious ceremonies and for carving.

The sandal bearing area of Coorg lies between the altitudes 2,000′ and 4,000′ above mean sea level. The rainfall here varies from 40 to 100 inches. Sandal occurs mostly in the un-reserves and private lands and comparatively very little is found growing in reserves. No land, containing sandal trees can be granted, sold or leased for any purpose. Sandal trees growing in private lands have to remain the property of the Government. The holder has to take all reasonable precautions to preserve all such trees and to protect their host plants marked by the Forest Department. A forest officer may enter upon any land and tend, uproot and remove any sandal tree growing on such land. While removing sandal trees from private lands some bonus will be paid to the owners of such land.

Composition and condition of the forest crop in the forests where sandal has its home.

Most of the unreserves are good sandal bearing areas containing abundant growth of sandal. As the growth in these unreserves is of a semi-evergreen type with a rainfall of 60 to 80 inches, sandal grows very well here, often reaching a height of 60′ and a girth of 40 inches. Its associate species in such areas are *Artocarpus hirsuta*, *Eugenia jambolana*, *Lagerstroemia lanceolata*, *Linociera malabarica*, *Casearia tomentosa*, *Dalbergia latifolia*, *Melia dubia*, *Albizzia* spp. *Bombax*, Vitex Negundo *Pterocarpus marsupium*, *Pongamia glabra*, *Acrocarpus fraxinifolius*, *Cedrela toona*, *Flacourtia montana*, *Mussaenda frondosa*, *Careya arborea*, *Gmelina arborea*, *Grewia* sp. *and Bambusa arundinacea*.

Where the rainfall is 40 to 60 inches, this semi-evergreen type changes gradually into the deciduous one. In this area sandal grows to a fair height, often reaching 40 ft. and a girth of 36″. The danger from suppression to sandal from its associate species is less in this area than in the semi-evergreen forest. The forests are fairly open and *Dendrocalamus strictus* usually occurs in the under storey. The associate species of sandal here are; *Diospyros montana*, *Zizyphus* sp. *Cassia fistula*, *Garuga pinnata*, *Schleichera trijuga*, *Stereospermum chelonoides* and *Albizzia* sp. The occurrence of *Dendrocalamus strictus* may be taken roughly to differentiate the deciduous from the semi-evergreen type.

In areas where the rainfall is less than 40″ and the climate is very hot in summer and the soil poor and gravelly, the deciduous type is replaced by scrub forest wherein growth and development of sandal is poor. The associate trees here are *Acacia suma* *Diospyros montana*, stunted *Anogeissus*, occasional *Melia*, *Terminalia chebula* and *Phyllanthus*, and the soil covering is a kind of dense grass which prevents soil aeration throughout the year.

Plantations have also been formed in reserves, mostly in the semi-evergreen and deciduous types. In plantations where tending has been neglected in the past, especially in the semi-evergreen type, sandal has been badly suppressed and in many cases killed by the dense shade of fast growing species resulting in its patchy stocking and poor development.

Injuries to which crop is liable.

'Spike' disease causes considerable damage to the sandal forest. Forest fires also do appreciable damage. The fire scorched sandalwood fetches low prices even though its oil content is stated not to be affected by scorching. As most of the good sandal trees grow in the unreserves, which are open to uncontrolled grazing, a great deal of fire damage to sandal is directly attributed to the indiscriminate burning of these areas in hot season to secure pasture for the cattle. The only remedy in such cases is to minimise the serious fire damage by early burning of the area. The sandal trees and their hosts in private lands are not properly taken care of, since land owners are given very little bonus while extracting sandal trees and naturally they are anxious to get rid of those trees.

Method of extraction.

Only dead and spiked trees are prescribed to be removed and therefore no particular silvicultural system is adopted. In old plantation all dead and spiked trees marked for

thinning are prescribed to be removed. The annual coupe is 1/4 of the total area of each felling series of the working circle and is fixed more for administrative convenience than on the basis of an equal annual yield. The extraction, cleaning and transport of sandal to the sale depot requires such close supervision at every stage that administrative convenience is the deciding factor.

The following *rules for exploitation* of sandal trees from the private lands are prescribed:—

(1) All dead trees yielding heartwood should be extracted.

(2) In uncultivated lands trees of 33″ and over in girth in saleable quantity should be extracted.

(3) In cultivated lands green trees of 21″ and over in girth, at 4′ height from the ground level, and containing heartwood, in saleable quantity should be extracted.

(4) All spiked trees yielding heartwood should be extracted after killing them by poisoning.

The felling should be done in serial order from one end of the sub-coupe to the other. All dead trees and stumps should be uprooted. This should be done by digging round them and using crowbars. The bigger roots should be sawn through so as to avoid wastage and to facilitate extraction. No part of the root should be left in the ground which contains heartwood of more than half a rupee coin in size. When a tree is uprooted the top and small branches which contain no heartwood should be lopped off and the branches containing heartwood should be sawn flush with the trunk, so that as clear a bole as possible is obtained. Under no circumstances should an axe or bill-hook be used for separating the branches or the roots from the main trunk. The main root should be sawn off at the crown and as little stemwood as possible should be taken along with it. The number of the tree and section of the tree must be noted on the sawn section of each piece of sandal wood. If any portion of the tree is too heavy to be carried it should be sawn into billets three feet long or multiple of 3 feet and the saw dust carefully preserved.

The trunk, branches and roots should be rough-cleaned by chipping off the bark and a portion of sapwood. Only a thin layer of sapwood should be left over the heartwood and in no case should the heartwood be exposed.

After the tree has been rough-cleaned, the pieces should be measured and numbered, and on the same section of each individual piece the usual hammer mark should be affixed. The individual pieces should be marked and labelled to show the sub-range the tree number, part of the tree to which it belongs (namely trunk root or branch piece) and its relative position. As for example, the first sandal tree extracted from Kargode sub-range would be numbered as follows:—

$$\frac{K}{1T_1}, \frac{K}{1T_2}, \frac{K}{1T_3}, \frac{K}{1R_1}, \frac{K}{1R_2}, \text{ etc.}$$

Here K stands for Kargode, and $1T_1$ means first trunk piece of tree No. 1 and $1R_1$ denotes the first root piece of tree No. 1.

When sufficient quantity of rough cleaned wood has been collected it should be despatched under escort to the final cleaning depot; on receipt of the consignment at the depot, the forester-in-charge will examine each piece and then weigh the whole quantity in the presence of the forest subordinate who escorted the consignment from the forest.

Final cleaning and classification

Before issuing wood for final cleaning it will be weighed. The final cleaning will be done in the following manner:—

(a) If the root has not been separated from the trunk, it should be sawn off at the base of the tree.

(b) The trunk piece should be sawn into billets of 3′ length.

(c) While cleaning great care should be observed so that no unnecessary heartwood is chipped off. The billets should present a neat appearance.

After each day's final cleaning is over, the final cleaning-depot keeper will separate the wood into the following three classes:—

(a) Billets (b) Roots (c) Chips.

Then, he will count the number of pieces falling under the bigger billets and root classes, weigh them and take them into stock. Chips will be kept in gunnies, weighed and brought on to stock.

Subsidiary silvicultural operations in natural sandal forests.

Tending:—In the past, adequate attention has not been given to sandal owing to financial

stringency; now it has been prescribed that all the sandal trees should be tended once in four years. From the administrative point of view tending is better done from June to November. As far as possible it should be done along with the extraction of sandal. In the case of seedlings and saplings shrubs, useful as hosts are retained and other unwanted growth like *Lantana should be removed* to provide more space for the development of sandal. When practicable, around groups of young regeneration a thorny (or other) fence may be erected to serve as protection against grazing. Full overhead light should be provided by judicious lopping off of the over topping branches of the neighbouring trees.

In the case of sandal trees, branches of other species interfering with its crown development should be revomed. If there are too many hosts, the best one should be selected and the other quick growing trees such as *Kydia*, *Trema* and *Grewia* should be felled or killed. If the tree is being smothered by Lantana on other obnoxious weed growth, such growth should be removed around the sandal tree to a radius of 3'-4'; climbers also should be cut. If too many sandal trees are found growing close together thinning should be carried out to give the sandal an espacement of 15' to 20' depending upon the size of the trees retained and their host ratio. Only the best and healthiest sandal trees should be retained in thinning.

Spike control.—'Spike' detected in the annual coupe in the course of sandal extraction and also in the blocks prescribed for special tendings, should be promptly treated with *Atlas solution* and such trees completely killed. The branches of spiked trees must be cut, collected away from the sandal and burnt. The killed trees should then be uprooted, rough-dressed and sent to the depot. Sporadic case of spike noticed in course of inspections should also be dealt with accordingly.

Spike resistant hosts should be selected. The following list shows the degree of resistance in each case:—

(1) *Cassia siamea* ..	Most resistant
(2) *Melia indica* ..	,,
(3) *Semecarpus anacardium*	,,
(4) *Strychnos nux-vomica*	,,
(5) *Bamboos* ..	,,
(6) *Anogeissus latifolia* ..	Resistant
(7) *Canthium didymum*	,,
(8) *Dichrostachys cinerea*	Resistant
(9) *Eugenia* sp. ..	,,
(10) *Ixora parviflora* ..	,,
(11) *Zizyphus oenoplea* ..	,,
(12) *Zizyphus jujba* ..	Fairly resistant
(13) *Webera corymbosa* ..	,,
(14) *Dodonaea viscosa* ..	Fairly susceptible

Sandal plantations.

The forest area allotted for plantation is either semi-evergreen or deciduous in type, containing a fair yield of timber, to cover the initial cost of forming the plantation. The silvicultural system prescribed may be designated as "Modified clear felling". A rotation of 60 years is tentatively adopted. The annual coupes are not clear felled, but during the extraction of saleable timber, about 20 medium sized trees per acre, suitable as permanent hosts, are left unfelled. Felling should commence from June onwards. The rubbish felling should be completed before the end of January.

Regeneration.—The lops and tops resulting from timber and rubbish fellings should be billeted, heaped uniformly all over the area and burnt, so as to get a fair and uniform burn. Burning of the slash should be controlled so as not to endanger or otherwise damage the trees retained in the area to serve as permanent hosts. The operation should be completed by the first week of April at the latest. The area will then be staked 10' × 10'. It has been proposed to introduce sandal provisionally at an espacement of 20' × 20'. At the intervening stakes *Cassia siamea* should be introduced as host plant by sowing.

In areas where sandal seed is not subject to damage by rodents, depulped seed should be sown at each stake along with *'dhal, (Gajainus indicus)*, the latter to serve as a temporary host during the first two years. *Tephrosia candida* should also be shown at the four corners of each stake and about 3' to 4' away from it. Sowing should be done towards the end of May or in the early part of June.

In areas where damage to sandal seeds by rodents is experienced, one year old, big nursery transplants with balls of earth, are recommended for planting. All planting work should be done during the rainy season in July. Basket plants may also be tried. Temporary hosts namely, *'dhal'* and *Tephrosia candida* should always be

sown whether the sandal is raised by sowing or by transplanting.

In the first year of formation each stake should be patch-weeded to a radius of 18″ all round. Lantana, either in the patch on in its vicinity, should be uprooted; shrubby under-growth should be cut only to the extent required to give sandal seedlings sufficient light. Any undue cutting of the surrounding undergrowth is sure to result in damage to sandal by increasing the danger due to grazing by wild animals. The first weeding is prescribed in July, the second weeding in August or September and the third, if necessary, during October.

Casualties in the first and second years should be replaced by transplants provided with a ball of earth. Replacements in the first year of formation should be done in the month of August and in the second year during July. During the second year one weeding towards the end of June should be done. During the third year one weeding with a cleaning should be done cautiously.

No thinnings are prescribed unless and until research proves their necessity.

Tending:—The following prescriptions are laid down for tending the plantations:—

(1) In older plantations time and money should not be spent on poorly developed and sickly-sandal.

(2) Having selected the trees to be retained, sufficient room for crown development should be provided by judicious lopping of the overhead shade.

(3) If surrounded by a large number of hosts, only spike-resistant hosts should be selected and retained.

(4) If too many sandal trees occur close together, the best are retained and the others cut away to maintain the host-ratio.

FORESTRY IN ANCIENT GREECE (1)

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The word 'Silviculture' as most foresters know, is derived from "Silva" the name of the Greek goddess of forest. Though every treatise on the subject "History of Forestry" coming from German and French authors commences its story with the middle ages there existed in ancient Greece and in the Pre-Christian era, of over two thousand years ago, a reasonably good system of forest management, for it is in the land of ancient Hellenes that the seed of scientific forestry first germinated and perhaps reached its adolescence, and it is on the foundations laid by the ancient Greeks that forestry of later days flourished and grew to be the stately tree of ample proportions as we see it in our times.

If we read through Theophrasts' book: "Natural History of Plants" (2) we can conclude that the old Greeks had considerably progressed in their knowledge of scientific forestry and especially so in the branch: "Knowledge of Forest Products". The descriptions of Theophrast which contain either his personal observations or those which have been taken from the narrations of others, and his instutional explanations of various forest-biological changes are so accurate, and they stand the test of modern scientific investigations so well, that his writings have rightly been considered the foundation upon which Plinius and others built up their forestry knowledge. For example, the accurate characteristics which Theophrast has attributed to the various tree species enable us to identify them without difficulty. Theophrast had already identified and distinguished two species of Abies (*A. cephalonica*) and its hybrid variety with silver fir (*A. pectinator*), and had even described the finer distinctions between their needles, in the same way as Mattfeld has done it in our days, now hardly twenty years ago; and Theophrast already knew that the latter species (silver fir) is found in Macedonia.

(1) The information contained in this article was gathered mostly from "Journal Forestier Suisse" 101e annee, Janvier 1950, pp. 38-44.

(2) Sprengel, K., "Theophrast's Natur-geschichte der Gewuchse". (German translation from Greek original).

He distinguished accurately between *Pinus brutia*, which he called idais-pine, from *Pinus helepensis* (strand-pine); and this distinction we were able to make only a few years ago; in fact, for a long time, these two species were considered to be identical.

Apart from the matters of Forest Botany, Theophrast also described plant-physiological and forest-biological matters. For instance, he associated the defoliation of trees with the onset of wintry conditions, exactly as we do now, and made very interesting observations on the causes leading to early or late defoliation. He wrote, for example, quite correctly, that trees standing on dry and poor soils shed their leaves earlier in the season, and that, the older trees shed sooner than the younger ones. He said, in the case of evergreen trees defoliation proceeds in such a way that while some of the leaves dry up, others sprout and expand at the same time. In this connection Theophrast described a Platanus tree near Gortyna in the island of Crete which does not shed its leaves. In the same connection, he also made the correct observation that the evergreen trees of that locality have smaller, thicker and tougher leaves and also have a certain kind of scent (ethyreal oil) which is capable of reducing transpiration.

Theophrast distinguished different types of roots or root-systems, as also slow growing and fast growing tree species. He quoted examples in this connection from forest trees which do not conflict with our present day knowledge.

Theophrast came to the same conclusions as we have done to day about the ecological demands made by various tree species on light and factors of the locality. He not merely knew correct facts about the coppicing power of certain species, but also raised the question whether the stump-and root-sucker shoots of a tree could be considered as part of the same tree or of another, which fact indicates that he had considered the question of their forming independent root systems; and this question has been the problem of investigation up to very recent times. Theophrast also pointed out the influence of the degree of crown-closure (canopy-cover) on the growth of stems in a forest when he stated—" Trees standing crowded grow and develop much better in their height; they are therefore free from knots, straight and slender; trees standing individually grow better laterally and in diameter; they are more stunted, knotty and on the whole stronger than those which grow crowded together." Theophrast should therefore be probably considered the harbinger of the principle of 'Thinning.' Further, he also determined the fact that trees growing in their own natural habitats develop more handsomely and also attain larger dimensions; and this fact he did not mention merely from intution but based it actually on his observations of the growth of exotics, *i.e.*, of those species which he found growing in habitats to which they were not accustomed. It is perhaps unnecessary to point out that this observation forms the basic principle of plant-sociology which has developed in our times.

Theophrast also described in detail the technique of planting, manuring and tending of the planted stock. Xenophon, another Greek writer, has also given a lot of interesting information on the subject of planting in his book " Okonomikus ".

Theophrast dealt with various problems concerning Forest Utilisation and Forest Protection; for example, he dealt with the properties of timber, uses of wood, wood-charcoal, resin-and gum tapping and such others; and many of his statements hold good even to this day.

The following are some of his statements:—

(1) Trees which have to be debarked are best felled in the season when they sprout because their bark can be easily peeled at that time; to obtain maximum strength from its timber a tree should be felled when its annual growth has completely stopped and its fruits have already ripened.

(2) If felled when their annual shoots are not yet fully developed, trees do not give off root-shoots. If, on the other hand, they are felled after the fruits ripen, they give off such shoots (Loden?)

(3) Winter conditions setting in at the usual time are not harmful to trees, even if such winter is severe.. On the other hand late frost (during sprouting of shoots or flowering) is dangerous, because it is followed generally by the outbreak of diseases and insect-calamities.

Theophrast recommended 'root pruning' as a means of encouraging fruit and seed development in trees, which again agrees with the theory of Klebs.

Chlaros (1885) and Kontos (1929) are but right when the former speaks of the wealth of knowledge of the old Greeks as the " Science

of Forestry "and the latter calls forestry the "Science of the ancient Greeks".

In ancient Greece, the forests in the neighbourhood of large towns and other centres of population had already been destroyed, and the Greeks had therefore taken measures for the protection of forest stands; such measures consisted, on the one hand, in cultivating trees, declaring particular forest areas "holy" and thus defying and glorifying the "nymphs" of the forest, the most well known of whom "*Silva*" came to be identified with "Forest" and gave rise to the word "Silviculture"; on the other hand, the Greeks also framed laws entailing severe punishment to those who were found guilty of forest offences by forest protection personnel.

Sophokler says that apart from their love for plant world, the Greeks were also afraid of the laws of their land; and, according to Aristotles the forest personnel were all Government servants with a high sense of duty. We are perhaps right therefore, in assuming that the Silvan laws and measures of forest protection had a wholesome effect on the conditions of the forest; this probably accounts for the good state of preservation of the forests of Parnis, Pentelikon hills and those found on the level country in the valley of the Attika.

As stated by Buchsenshutz and Sklawunos the fact that during the siege of Athens in 84 B.C. Sulla got felled the holy Haine and the trees of the Acadamy for storing timber is not due to the general shortage of timber in the locality, but merely to the fact that like the army at all times the soldiers removed the timber where it was most convenient to them to do so.

As regards timber supply to the large cities of the period, it is known that the required firewood and charcoal was produced in the neighbouring forests. The charcoal makers of Aristophane manufactured charcoal out of wood in the evergreen leathery-leaved forests of Parnisberg and met the demands of the Athenians for this produce. Bopkh says that birch wood was nowhere used for making charcoal, and this is also quite unlikely because the nearest forests of birch were situated about 100 kilometers away to the north of Athens. The essential commodity, namely, ship-building timber, was imported either from the colonies or from other States having plenty of timber, by treaties specially drawn up for the purpose. The utilization of colonial forests was carried out in an unregulated manner as is usually done by occupying powers even to this day, with a view to conserve and properly utilize their own forest resources. When, for example, a citizen of Athens wanted to found a new state in Crete he asked—"How about other matters? How do plains, hills and forests stand distributed in our new State? Moreover, how about the availability of timber for ship-building in this part of the land?" This questionnaire indicates not merely the great importance attached to the continuous undiminished supply of forest produce for the new State from its forests, but it also shows the value which the Greeks attached to the correct planning of land use.

These few examples are adequately indicative of the fact that in ancient Greece the natural sciences, and especially science of forestry, were well known and understood, and these formed the foundation upon which the forest science of today was built up in later years as a superstructure. If as a result of the over-shadowing achievement of the ancient Greeks in the field of fine-arts and culture, only scanty evidence of their accomplishment in the domain of forestry have come down to our times such scientific evidence is yet ample to show the progress of the knowledge of forestry which had been achieved in those very ancient days.

ORIGIN

W. F. COOMBS,

DEPUTY CONSERVATOR OF FORESTS, NAINITAL.

Man's quest after knowledge is insatiable. We are continually learning new things, making fresh strides in every sphere of art and reasoning design and invention. Yet has it not been said "there is nothing new under the sun"? This is probably explained by the truism that half the world does not know how the other half lives. Much of what knowledge we do acquire are self evident fact or old truths but in a new garb. Life is full of paradoxes and knowledge itself is bounded by the limits of human conception. The most we do is to ascribe certain values or draw certain inferences. I was surprised to learn the other day from an interesting article on quails that these small birds cannot fatten south of the Mediterranean and that they cross the Mediterranean in the autumn from their northern nesting homes usually by night thus arriving on the Egyptian shores at about 8 in the morning where they are met by traders who hoist fine nets and other devices and so trap tens of thousands of them in their exhausted state. Many thousands being drowned on the long flight. Or again that dried sardines are a staple diet for camels, and that when the crop of sardines fails or diminishes, the camels go on short commons. Some consolation to us who are heavily rationed here to know that even camels have their trials and food problems to endure. One of the many straws that proverbially break that creature's back. But to revert from these digressions, I see from a very interesting article in the *Indian Forester* that it is proposed to investigate fossilised plants of the first and subsequent Interglacial periods. Therein it is stated that great disturbances in the climatic and other conditions in relation to the environments would produce "a wholesale migration of the existing plant communities" to more congenial places. Is this really a scientific fact? Do plants migrate in this way ? Are they capable of choosing their habitats or are they also to endure the struggle for existence, per chance to survive where nature has been pleased to throw them or to die valiantly gamely fighting to the last. Amongst the other notable aims of the study is that of the Great Ice Age itself. Also the affects of that Age on prehistoric human cultures. All this it is hoped will result from the study of fossilised leaves and it will doubtless occasion much curiosity at least to know who were these prehistoric men and what their mode of life. Even assuming that it is discovered that they were giants and smoke pipes 5 feet long, will really not help us in this dynamic age. But fossils have always been highly interesting subjects of study. I seem to remember that sometime back fossils of frogs unearthed in Russia—(that sublime country where fresh discoveries are claimed almost daily)—mere petrified fossils seemingly dead for centuries—were brought to life by suitable cultures and that seeds (and this is perhaps more genuinely true) which had laid in deposit for countless years had been coaxed into budding life under suitable process. And so we again come to the main subject which is life or origin of species. According to many authorities, headed by Darwin, we are told that life evolved itself and probably had its origin in water *i.e.*, aquatic. The dinosaur and diplodocus of the Jurassic and Cretaceous Periods flourished and died (not migrated). Fish and plants pertain to the Second Period or Primary, conifers to the fourth or Permian. Primitive man is comparatively recent and belongs to the Post Tertiary, coming after horses and monkeys. The Great Ice Age is put at between 20,000 to 60,000 years ago. Darwin says we have descended from monkeys, thanks to the similarity, but it has not been reliably established what monkeys came from, unless from birds. An interesting article by a noted scientist, entitled Nature and Nurture, which I was reading the other day, stressed the importance of environment and suggested that originally we must have had wings though not using enough, became arms. Legendary horses too had wings. That is all very well as an inference but it still does not explain origin satisfactorily. Most religions whether ancient or recent, can carry us back reliably only up to a certain stage. Beyond that it is purely conjecture—darkness or void, things without shape and at that point all acknowledge God, whether by 'Om' or by any other name. It is noteworthy that in the very first Formation, the Archaean, there are no fossils. I think it can be inferred that some forms of life, particularly of the lesser plants *e.g.*, herbs and grasses, as opposed to life which is created, have the power of starting on their own under suitable environments and of continuing thereafter so long as conditions remain favourable. Energy is not only heat, light or friction; it is a constant which occurs in all matters and can evolve life. We are rather apt to consider life as something entirely separate from the matter in which it is encased, something foreign

or ethereal to it. Instead and for all we know, it is something strongly subordinate to the form in which it is contained, whether the plant cell or the animal tissue.

It is always a matter of great interest to ponder just how and when our magnificent deodar *Cedrus deodara* and pine forests originated. Each occupies its own zone and lives its own mode of life. Geologically the Himalayan Uplift is comparatively recent. Many years ago when doing a Working Plan under dear old Bailey (now passed, over to the other side), remember how he would never fail to comment on *khair* (*Acacia catechu*) trees which we found growing on the lower hills says at about 2,000'-3,000' elevation. He was a geologist and would always stop to describe how in the folding up of hills these essentially plain species found commonly on flat riverain types, were carried up hill in the folding up of the land. The same could doubtless be said for the other common plains-trees found in the hills *e.g.*, sal (*Shorea rotusta*) and asna (*Terminalia, tomentosa* and also for some scattered *semal* I noticed the (*Bombax malabaricum*) other day growing in a purely *kokat* (miscellaneous inferior species) and pine forest at nearly 4000', elevation in the Gola valley. But their outward shape was quite unlike that of the common *semal* we see in the plains, being as gnarled and crooked as the oak. That is all very well but it does not account for the essentially hill species and in particular the pine and deodar. Are these then survivals of one time plains species ? Was the uplift as universal as supposed or did it affect only part of the terrain ? Is it not possible that the up-lifts is of much greater antiquity than at present reckoned ? Which brings me to another paradox and that is that it is commonly held that the hills are of great age. We have the expression "as old as the hills" and there is that beautiful hymn

"Before the hills in order stood,
" Or Earth received her frame"
" From everlasting thou art God,"
" To endless years the same."

The evolution and origin of plant species is thus just as interesting and important a study as that of fossils.

CONTROL OF LANTANA CAMARA

BY V.N. PRASAD, D.D.R.,

RANGE OFFICER, RAKHAMINES, BIHAR

Lantana is a straggling or scandant shrub with small recurved prickles on most of the branches. Lantana exists along roads, nallas, around villages and cultivated areas. It is an exotic which comes from Central America. The plant is a terrible pest to the forest. It spreads by leaps and bounds. It has got a massive root system. It does not allow any other species to propagate round about its vicinity. It has got a peculiar characteristic like sal *i.e.*, after being cut flat to the ground it sends forth the new shoots within a short period which also grows to the same original height.

It occurs in dry as well as in moist localities. It has been seen that the places which had once been thickly populated have now become full of Lantana camara. It is not only a pest of the forest but also of the cultivated areas. It propagates by wind as well as by water. In order to check its propagation it must be cut before the time of flowering and fruiting. Many provinces are carrying out their experiments in different ways in order to remove this species.

The writer suggests the following methods to check its propagation:—

1. Cut all the branches flat to the ground and let the debris remain on the roots till it is dried. In doing so the roots will not get light and so new shoots will not appear. The portion of the species from where the shoots were to come will also become dry. Burn the dried debries on the very spot without removing it from the roots. Then dig the root systems and burn the roots on the very spot. This will help to check its propagation in a scientific way.

2. There is need for an all out effort to remove Lantana from cultivated lands, forests,

villages etc. This should be brought to the notice of the public through the coordination among the departments of forest, agriculture, public works and the rural development committee. The spirit of "kill Lantana and save forest and paddy fields" should be instilled in the minds of the people. The result would be marvellous one.

WASTING HERITAGE OF OUR NATION

By P.V.C. Rao, Graduate, I.E.E., M.I.E.T. (Lond.)

Corporate Member of the American Society of Agricultural Engineers.

Harrowing accounts of dust-storms and sweeping gales belabouring towns and villages are now swarming through in the relegated corners of the press. There is a recent account of violent dust-storm shaking Vellore to its roots. Stories of house tops blown out, pedestrians choked and bewildered and scattered trees uprooted are very common in the Central Indian plains and the Deccan plateau. If the devastation is now slowly creeping to the coastal belts as is evident from the phenomenon witnessed at Vellore, the problem is definitely attaining stupendous proportions.

It is the problem of the soil of our land being blown out by wind by way of dust storms. With the clearing of the forests and the overgrazing of the pastures, the land becomes exposed to the vagaries of wind and water. The destructive cultural practices render the soil extremely malleable and the sweeping gales gaining in momentum with lack of wind breaking trees, collect the rich soil in fine particles of dust which is deposited on locations where it is most harmful. We can imagine the colossal waste which these dust-bowels carry in their nefarious visitations—the waste wrought by the nature's gift meant for producing rich food and fodder for the sustenance of life on earth.

If deserts can tell their tales, a yawning gulf of bewildering account aghausts us. Geological surveys revealed that the majority of the deserts of the world had been once prosperous with mighty civilizations. The expensive deserts of Central Asia and North Africa even today bear signs of well-planned irrigational projects and organized agriculture; nevertheless, the political and social upheavels, the plundering invasions and the zealous exploitation of the land, led to rapid soil exhaustion. The soil wash silted channels and water courses changed their direction of flow. The nomadic type of the transitory agricultural practices ate up the vegetative cover, and the exposed slopes and valley-lands became stripped off their soils by slashing rains and withering gales. The scarred earth became slowly scorched, and deserts swooped on once smiling lands. The Mangolian invasions lashed up the Mesopotomian plains which along with Northern China and the Tibetan hill sides, lost their faces completely. Today, they are interwoven with relishing orchards, with scattered green meadows, and expansive desert lands, into which the hill-born rivers and rivulets merge out all recognition. The Polar and Equitorial climate change in rapid succession in these regions.

Such is the bewildering tale of the lost soil. And this tale has been taking a heavy toll in our country whether we go to the expansive Deccan plateau with the undulating barren lands on the rich black-belt regions, or to the expansive Central Indian plains stretching from the Vindhya range to the Crown of the Rajputana, or to the land of the five rivers with their bewitching wheat fields, or the desert land of Baluchistan where the barrages cut a silver line through the red herring of the plundered waste, or the heavy rainfall regions of the Bihar and Assam valleys where floods swoop down the gullied lands submerging villages and townships in their swaying tidal waves, or to the sunlit Travancore and Malabar uplands groaning under the heal of poverty amidst plenty of rainfall, or to the rich Circars' coastal belt in the East and the Konkan in the West, the same phenomenon and the same tale of the lost soil mock at our face in all its nakedness. The destruction is the same, though different in magnitude and intensity from place to place.

Our land is rapidly becoming fragile and our climate is going from bad to worse. Lakhs of

villages and towns are suffering from the basic human necessity of drinking water. Violent floods and sweeping gales are becoming the order of the day. Our reservoirs are rapidly filling and the harbour mouths are getting choked with sediment. We are draining our limited resources in order that we may preserve at least on the starvation level. The demon of food scarcity has been threatening us.

It is a colossal blunder to remain any more complacent about the wasting heritage of our nation. We ignore our soils to our peril. Let us awaken from our lethargy and embark forthwith upon an intensive programme of Soil Conservation.

HIGHWAY PLANNING AND SOIL EROSION.

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"It was suggested that Engineers should make it a point to pay attention to the road-sides as much as they do to the road surface. The road-sides should have easy slopes and proper drainage ways which should without fail be 'planted to grass and fertilize". These remarks of Dr. Shuhart, the U.S.A. Soil Conservation expert, in his report on erosion and preventive measures in India, show the importance of taking effective measures against highway erosion in our country. During his tour through the various Provinces and States, Dr. Shuhart noticed intensive erosion damage caused by the faulty laying of highways and the neglected maintenance of the road-sides.

Highway erosion has been recognised in America as one of the potential sources of erosional damage causing enormous losses by way of maintenance costs to the highways, and accelerating the sheet and gully erosion on the adjacent lands. The mode of construction of the secondary highways is generally defective in our country and little care is bestowed to control soil washing along the roads. In numerous localities, road-side ditches are permitted to enlarge until roadbeds are threatened with undermining; fills are left bare very often until sloughing becomes active as a result of gullying and sheet washing. The remedies employed to correct these conditions are often of a temporary nature such as resurfacing or filling washouts with earth or gravel, installing flumes or overpasses, and building small check-drains. In America as a result of detailed investigations, the Soil Conservation Service summarized as follows the general highway position in U.S.A. "Upkeep of the far-flung road system of the United States, covering some 3,200,000 miles, constitutes a heavy public expenditure. It has been estimated that, under state systems, maintenance costs approximate 300$ per mile annually. Surveys indicate that nearly one third of this cost may be charged to the direct or indirect effects of erosion. Estimates of damage to county roads, of which there are more than 2,650,000 miles, are not available, but the damage probably is more serious than that along the State and Federal systems."

In the American method of highway erosion control, trees and fertilized grasses on eased slopes play an important part. They have developed a special type of cross section for the road bed and the ditches conforming with the general requirements of sound construction and at the same time offering economical control of erosion. When roads are constructed, they necessarily cut the terrain at odd angles and intersect and divert run-off from numerous natural channels. Culverts and other structures should be located with particular care, so that gullying or other erosional damage to adjacent lands may be minimized. Steep road-side slopes and ditches with acute angle of transitions should be prevented. Wherever cut slopes are encountered, interception ditches with ample capacity, gentle grades not susceptible to erosion and outlets that safely dispose of the run off are constructed. The slopes themselves are settled to a thickly growth of grass and trees planted in contour trenches.

Wherever slopy uplands under cultivation are draining into the roadside ditches in low rainfall areas, it will be necessary to adopt contour furrows, sodded diversion channels

and level terraces for the adjacent lands. For best results in these directions, complete co-operation of the land operators should be enlisted. Special designs have also been developed under the American Highway erosion control practices for the construction of cross-drains and culverts to check the development of overfalls and gullying above the structures.

In our country we are at present embarking upon a nationwide programme of highway development at enormous capital outlay. We will do well to regulate our planning with effective erosion control measures so that the heavy maintenance and replacement charges may be curtailed to the barest minimum. Our present mode of construction and maintenance necessarily calls for a good deal of revision as Dr. Shuhart, the Soil Conservation expert, had pointed out.

RATE OF GROWTH OF DALBERGIA LATIFOLIA

BY D. D. CHOPRA, P. F. S.,

SPECIAL FOREST OFFICER, MIRZAPUR

It will be useful for Forest officers interested in plantation work to know that a nursery was started in Dudhi in district Mirzapur (elevation about 900 feet above sea level) in 1926. (*Dalbergia latifolia*), teak and *Kamhar* (*Gmelina arborea*) seed were sown for raising seedlings for planting in the forest. Some of the plants were left to grow in the nursery which have been growing very vigorously. The biggest *shisham* measured by me on 1st March, 1949, *i.e.*, after twenty-two growing seasons, is 5 ft. 8 in. in girth or say about 22 in. in diameter at breast height, which is very good. Dudhi is a hot place with a very short winter and long growing season, and the average total annual rainfall in about 45 inches.

THE EVOLUTION OF THE SAL NATURAL REGENERATION TECHNIQUE AND SUBSIDIARY SILVICULTURE IN THE FORESTS OF HALDWANI DIVISION

BY D. D. CHOPRA, P. F. S.

SUMMARY

The history of the forests of Haldwani division from the pre-British period has been narrated. Past systems of management under various working plans have been given. The mistakes made in the past, so far as they concern the natural regeneration of sal, have been pointed out. The role of the Middle storey kokat, which consists of inferior species of low marketability and useless shrubs, in nursing and securing the natural regeneration of sal has been pointed out. Future lines of management have been indicated.

EARLY HISTORY 1818—1860.

The history of the Kumaon forests in which the present forests of Haldwani division were included in the past, consists of, broadly speaking, a record of vississitudes common to the majority of forest areas in Uttar Pradesh during the last century. The ruling power had derived revenue by imposing dues on the produce exported, and the British rule continued this simple but uneconomic practice for some time. This system was profitable alike to the lessee and the exploiters. For several decades the fine forests were heavily overworked, everything saleable in accessible areas being mercilessly felled. Yet the average annual revenue was only about Rs. 3,700 between 1818 and 1847. In 1826, one Mr. Trail excluded the cutting of sal on the flats immediately adjoining the lower hill ranges; thus started perhaps, the first forest reservation in Kumaon. In the middle of the 19th century the forests were recklessly felled for sal railway sleepers, so much so that ignorant speculators so denuded the forests that for several years afterwards the departmental officers were chiefly engaged in extracting the felling refuse left behind.

In 1861, Major Ramsay reported to the Government of the exhausted state of the forests and recommended their closure and conservancy. He was appointed the first forest conservator. He abolished the farming leases, introduced fire protection, regulated grazing, stopped indiscriminate fellings, and started a system of tree marking. He also improved the roads and opened new ones. The immediate result was a greatly enhanced forest revenue and a surplus between 1859 and 1868 of nearly 7 lakhs of rupees.

Early administration by the Forest Department. 1868—1880.

During this period the forests of Kumaon (including those of Haldwani) were gazetted and formally demarcated as State Reserves. These reserves consisted of the most valuable sal forests in the lower hills and *bhabar*, and some tracts containing *Acacia catechu* (*khair*) and *Dalbergia sissoo* (*Shisham*)

Past Systems of Management.

The first working plan for the forests was drawn up by Sir Dietrich Brandis in 1881. This provided for the removal of the excess growing stock from the virgin forests of Nandhaur valley which had not hitherto suffered from over exploitation. An annual quantity of 50,000 cft. of sal timber 6 ft. and over in girth was extracted under the plan for 5 years.

In 1886 there followed a more comprehensive scheme, Mr. Hearle's working plan, which provided for the working of the better quality hill forests, *i.e.*, those of the Nandhaur and Kalaunia valleys, with Chini, Nagdhan and Jariakhal blocks and was based on complete enumerations. It prescribed a yield of 1,000 mature sal trees (over 6′ girth).

In 1894, the first working plan for the whole division was drawn up by Mr. Bryant. This plan divided the forests into five main classes :—

(*a*) Higher hill forest of *Pinus longifolia* (*chir*) and *kokat* (miscellaneous species) (b) Lower hillforest of *Shorea robusta* (sal) *Terminalia tomentosa* (*sain*) and *chir* (c) sal forest of the *bhabar*, *tarai* and Kotahdun (d) miscellaneous forest of the *bhabar* and (e) *Dalbergia sissoo* forest of the Sarada islands. The working was regulated under 9 working circles. For the sal areas the silvicultural system prescribed was " Selection and Improvement fellings" removing all sal and *sain* 6′ girth and over and $\frac{1}{4}$ of the $4\frac{1}{2}$—6′ girth class in 36 years (2 felling cycles)

Fig. 1

Shorea robusta. Selection type forest of Q.C. III/II with all stages. Deteriorating overmature (C & Extreme L) middle aged poles (L) and small poles, saplings and whippy regeneration.

Photo. H.G. Champion
Nov. 36.

Sudlimath Compt. 7,
Haldwani division, U.P.

FIG. 2

Shorea robusta. Shelterwood fellings in Lakhmanmandi, Comptt. 4. Haldwani division, U.P.

Photo. E.A. Smythies, 1921

Mr. Bryant's plan was followed by that of Mr. Collier in 1914. This is noteworthy as embodying one of the first large scale attempts in India to convert a sal forest to the Uniform system. The forests were divided into 6 working circles. Collier's plan provided for a total conversion period of 120 years (which was considered to produce sal of 5 ft. girth) with 6 sub-periods of 20 years each. This plan was duly followed for 6 years, when owing to some changes in territorial jurisdictions, the conversion—rotation—was lowered to 90 years with 3 periodic blocks of 30 years each. Annual coupes were abolished and also any fixed silviculture for the regeneration block, which was to follow whatever lines the latest experience and research should indicate.

Mr. Collier's plan was replaced in 1925-27 by that of Mr. Ford Robertson, which divided the working plan area into 6 working circles. For the Hill working circle Selection with an area yield under a felling cycle of 15 years and an exploitable diameter of 18 in. when maximum height of trees was below 70 ft. and 21 in. when the height was 70 ft. and over was fixed. For the Conversion working circle, the rotation was raised to 120 years with periods and 40 years each. Selection fellings were also prescribed for Periodic Block II, with the object of removing the overmature stock.

Mr Collier's plan was replaced by that of Mr. Raynor, who, after careful consideration of the difficulties of sal regeneration, allotted the forests to 14 working circles. In the Hill Selection working circle the silvicultural system remained substantially the same as under the old plan, *viz.*, Selection fellings and thinnings under a 15-year felling cycle, with an area yield and a limit of 50% on the removal of saleable selection trees of sal and *Adina cordifolia* (*haldu*) based on Smythies formula, subject to their being silviculturally available.

In the Sal Conversion working circle, the "Floating Periodic Block system" (*Quartier bleu*) was introduced. Regeneration was under the Shelterwood —conversion system supplemented by artificial sowings where natural regeneration failed. The conversion period was fixed at 100 years with a regeneration period of 20-30 years. In areas under natural regeneration the general method adopted was clear-felling over well developed whippy and woody regeneration, or heavy fellings leaving 25-30 trees per acre over whippy regeneration followed by a burn and game-proof fencing and a regime of intensive winter plus rains shrub and grass-cutting until the woody shoots reached establishment stage.

Apart from controlled burning to induce sal regeneration *de novo*, the whole circle was strictly fire protected. Grazing was allowed everywhere except inside fenced areas. In Moribund Sal working circle, where the crop was suffering from waves of drought mortality with absolutely no progress in sal regeneration, clearfelling leaving a shelterwood of 20-30 trees against frost and artificial regeneration by *taungya* (agri-forestry) was prescribed for the allotted areas and selection fellings for the remaining unallotted areas. In the *bhabar* Selection working circle, which comprised of all the remaining sal areas of the working plan where there was no natural regeneration, selection fellings with thinnings over a 15-year cycle with an area yield was prescribed.

Mr. Raynor's plan was followed in 1946-47-48 by Sri. D.D. Chopra's scheme. Here, in the Sal Conversion working circle felling of mature sal trees in the Floating periodic block as well as in the unallotted areas was suspended. Only dead, definitely dying, damaged and uprooted sal trees and green trees of exploitable size of *Terminalia tomentosa* (*sain*) and other saleable miscellaneous species whose removal was silviculturally desirable, was permitted together with thinnings in congested pole crops. Greater stress was laid on the importance of thinnings and cleanings in plantations, together with tending operations in young sal regeneration area, and also on necessary burning operations to induce sal regeneration, in the Floating periodic block areas with deficient regeneration.

Results of past working, sal conversion working circle.

The present forests started from a state of ruin as described above and were nursed up by careful protection and conservancy from 1860 onwards into their present, more or less uniform, condition. As stated already, Mr. Collier's plan of 1913 was one of the earliest in all India to introduce the application of the conversion system of sal on a large scale. It was anticipated, when the system was introduced, that at the end of 20 years the crop would consist of saplings and poles of naturally regenerated sal. It was found by Ford Robertson in 1927-28, however, that the

regeneration process was slow and uncertain. Conversion fellings coupled with fire protection encouraged a rank and extensive growth of weeds over much of the area. In 1936-37, Mr. Raynor wrote in this connection : Except in parts of the Sela experiments there is little further success in regeneration to record " etc. " and far from realising Collier's forecast the results to date show that in no single area have the 1913 seedlings and subsequent recruitment been brought to establishment (*i.e.*, to the sapling stage 10' high and upwards) and in most of the areas the regeneration is practically all lost ", etc.

From 1914 to 1933 the regeneration fellings consisted of preparatory and seeding fellings involving a very heavy opening of the upper canopy and practically complete removal of the middle—storey *kokat* (miscellaneous species) and undergrowth. Dominated and suppressed advance growth of sal was also drastically removed. Then nothing was done for years and the shrubs grew up into a dense and often impenetrable underwood which effectually killed out practically all sal regeneration. During Mr. Raynor's plan a certain amount of success was obtained by fencing against deer, shrub—and grass cutting to favour sal or judicious opening up of the canopy in places followed by control burning, with or without shrub cutting. During the time of Raynor's plan it was difficult to get labour for rains shrub-cutting without which it is usually impossible to get up whippy sal regeneration over which the canopy had been excessively opened up and middle storey *kokat* removed, thus inducing uncontrollable masses of weed growth.

Conclusion. On the whole " we have achieved a certain amount of success in obtaining natural regeneration but our principal mistakes have been the following :—

(1) Over optimistic and excessively heavy fellings over young unestablished regeneration which was too small to respond or outpace weed growth.

(2) Drastic eradication of the middle and lower storey *kokat* which would have controlled weed growth helping sal regeneration.

(3) Neglect (or insufficiently intensive) shrub and weed cutting, during the period of World War II.

(4) Ineffectual artificial regeneration of sal wherever attempted, due to various difficulties inherent in the tract such as damage by porcupine, pigs, rats and elephants, deer browsing, labour difficulties etc."

The role of the middle-storey of kokat in securing the natural regeneration of sal.

Progress of sal natural regeneration

Two distinct phases can be recognized in the progress of sal natural regeneration :—

(1) **Preliminary phase**—From germination up to large-leaved whippy or small-woody stage.

(2) **Final phase**—From the time plants have reached the large leaved, whippy stage and are ready to grow up fairly rapidly, given the necessary light, and protection from fire, frost and deer-browsing, until they have reached the pole stage and are safe from frost and deer.

In sal *plantations* the preliminary phase is very short provided all goes well and may be said to be only 2 to 3 years of duration. This is because intensive soil working enables the seedling to develop a good root system at once so that it rapidly becomes strong enough to continue increasing its height every year without any dying back ; intensive rains weedings in the early stages and freedom from overhead shade are also necessary to obtain the best results, though the latter can only be given where there is no frost danger. Complete exposure to the hot weather sun is apt to be dangerous ; the only reason why more young seedlings in plantations do not die of drought and exposure to the sun is because intensive soil working enables them to develop a strong root system in the first year. In the case of natural regeneration the preliminary phase is generally a long one and may be anything from 8 to 20 years. Without soil working the seedlings get a bad start and it may take them many years to develop a sufficiently strong root system to enable them to go ahead without the annual dying back. In these early stages they are also not strong enough to withstand too much exposure to the hot weather sun. We should not, therefore, give them too much light and expose them to the danger of damage and death from drought. Once the final phase has been reached, however, much more light can and must be given together with intensive shrub and grass cutting preferably in the rains or otherwise in the

ensuing winter or hot weather, for their rapid development to established sapling and pole-stage.

Value of middle-storey kokat :—

The presence of a significant admixture of light-crowned *kokat* trees in the middle storey, under the main sal canopy, is now considered essential for ensuring the effectual progress in the natural regeneration of sal. It is unfortunate that sufficient importance was not attached to this in the past. After the opening of the upper sal canopy and the appearing of the natural sal seedlings on the ground, this admixture of miscellaneous trees and shrubs in the middle storey prevents an excessive invasion of grasses and low spreadings weeds and at the same time protects the young sal seedlings from drought and exposure to hot sun, but for which the sal seedlings invariably succumb in large numbers. The middle-storey *kokat* also prevents the heavy drip of rain water which occurs if there is nothing intervening the high sal crowns and the soil level ; heavy drip hardens the surface soil and also results in physical damage to the seedlings. Sal seedlings not only germinate better but grow and develop better under a cover of light crowned trees of miscellaneous species. Moreover it is known that pure, dense sal crops produce unfavourable acid conditions in the soil as a result of which seedlings after germination often die off in large numbers. During the Preliminary phase the presence of an adequate admixture of *kokat* in the middle storey is, therefore, absolutely indispensable under natural regeneration conditions.

Measures to rectify defective canopy and soil conditions.

In many areas in the Preliminary phase the middle-storey *kokat* of the Floating periodic block has unfortunately been destroyed in the past, while repeated burning has in many places induced an excessive invasion of the grasses. Our first effort must, therefore, be to encourage middle-storey *kokat* to reproduce itself from coppice shoots. This will only be possible if fires are excluded, and if funds permit, intensive grass cutting will be beneficial in such areas and will also help the sal seedlings.

Our observations show that a mixture of light grass and low weeds in more or less equal proportions, not exceeding knee height, usually provides a clear indication of soil conditions definitely favourable to natural sal regeneration. On the other hand an excess of dense and high grasses, which invariably result in excessive root competition and aggravation of frost hazard, is an indication of unsuitable soil conditions under which the development of sal seedlings either remains static or becomes retrogressive. In such circumstances rectification can be achieved by stopping burning and allowing copice shoots of *kokat* trees together with shruby undergrowth to grow up, thus bringing the growth of grasses under control by means of the moderate shade induced. Typical areas in the Floating periodic block of Haldwani forest division in which such remedial measures are required to reduce excessive grass are :—Dhan 1, part of Lakhmanmandi 1, Dolpokra 4, Sela 2 and 4a, Chungadh 25, Dulagadh 6 and Sudlimathla.

In damper sites which are quite frequently met with in the B3 sal tracts of Haldwani division, fire protection together with essential tendings after regeneration fellings (in which middle-storey *kokat* was usually drastically removed) has frequently resulted in an excessive undergrowth of evergreen shrubs, such as *Pogostemon*, *Milletia auriculata*, *Clerodendron infortunatum*, etc., which is also an indication of soil conditions definitely unfavourable to the natural regeneration of sal.

In such circumstances rectification can only be achieved by repeated, intensive or selective cutting of evergreen shrubs (to induce driage and inflammability), followed by burning for several years. In extreme cases total cutting of weeds may be essential to make burning possible. Later, as grasses begin to appear, selective shrub-cutting, with or without suspension of burning, may be found most suitable for achieving the desired equilibrium between grasses and weeds. Whatever procedure is followed, the importance of restoring an adequate middle-storey of *kokat* by allowing suitable coppice shoots to grow up must be constantly borne in mind. Typical examples of such areas are Lakhmanmandi 4 and 5 (Fig. 2) and the south eastern portion of Sudlimath 4.

Treatment of other areas in the Preliminary phase.

In other areas in the Preliminary phase in which the middle-storey *kokat* has fortunately not been eradicated, sal regeneration exists in the sub-whippy and whippy stages as well as in the small-woody stage. Further cautious

opening of the upper sal canopy over patches of such whippy and sub-whippy regeneration will accelerate its progress. It must be vigilantly borne in mind that middle-storey *kokat* must not be prematurely and unnecessarily thinned since it provides the light cover essential for controlling the undergrowth and for protecting the young sal regeneration. Additional light, if required for the young sal regeneration, can be provided by cautiously opening the upper and *not* the middle storey canopy but it should be remembered that when fellings take place there may be some casualties by breakages in the middle storey. Typical examples of such areas are Dulagadh 6, Sudlimath 3 and 4, Jaulasal East 2 and 5a, Chungadh 25, Dolpokhra 7, and parts of Sela 2, 4a and 6a.

Control burning. In portions of those areas where the middle-storey *kokat* has not been destroyed and in which sal regeneration is either deficient or still in stage (1) control burning annually for 3 or 4 years, or at least before a very good seed year, should be carried out to keep weed growth under control and also to encourage more seedling reproduction. These fires should be strictly controlled and should not be so fierce as to kill the middle-storey *kokat* or the flowers of sal trees. A suitable period for such burning is between March 15 and April 15. In areas with more grass, burning should be done at night. In an average area burning may be done by day to ensure the weeds being properly burnt. Preliminary cutting of weeds to ensure driage and inflammability will not be necessary.

Treatment of areas containing weedy advance growth.

Cultural treatment for areas containing sal regeneration in the final phase (*i.e.*, when the sal shoots are ready to put on progressive height growth) should be as follows :—

(*a*) A heavier opening of the upper canopy (leaving the middle-storey *kokat* canopy intact), taking care to leave an adequate shelter-wood for frost protection where necessary.

(*b*) Effectual game-proof fencing.

(*c*) Intensive or selective shrub and grass cutting during the monsoon. If rains work is impracticable, then two operations first in the period from November to January and the second in May-June may be done.

(*d*) Strict fire protection, except for carefully controlled slash-burning following item (*a*) above.

THE IMPORTANCE OF COMPOST IN THE PRESENT FOOD SELF-SUFFICIENCY DRIVE AND A FEW METHODS OF PREPARING IT.

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Abstract : We should improve our agricultural practices in order to make up the present deficiency in food grains. The importance of better manurial practices is self evident. Out of the 3 types of manures *viz.*, farm-yard manure, inorganic or artificial manures and compost, only the last can be produced immediately in sufficiently large quantities and at a very low cost. Also, it is decidedly superior to the artificial manures and, if properly made, better than the farm-yard manure too. A few simple methods of compost making are described.

We are short of food grains and cannot afford to import the deficits from abroad. Hence an early date for achieving self-sufficiency in food grains has been fixed by the Government and a country-wide drive is in progress to attain this target. There is not much of untilled land to be added to the area already under the plough. But our agriculture is very backward as compared to the countries of the West, or China and Japan nearer home. The yield per acre is very much lower and there is plenty of scope for improvement in this direction. The necessity of better manurial practices in this context is thus self evident.

A large part of the valuable farm-yard manure is lost to the agricultural crops because of the evil practice of burning cowdung as fuel. The eradication of this unfortunate custom is a very complicated matter and its solution will take decades, even if action on the right lines was taken immediately. The use of artificial manures on a large enough scale is not possible, because we do not produce much of these. Also, their careless and continuous use has been conclusively proved to seriously lower the soil fertility, especially in our tropical climates. Compost making on a country wide scale thus offers an immediate and sound solution of the problem. The constituents are readily available on the spot all over the country. The process is simple and very inexpensive. The product, all over the world, is acknowledged to be the best type of manure. Its popularisation would, in addition, contribute materially towards better sanitation in the country as we will be putting to a very good use all the rubbish, of vegetable as well as animal origin, which usually is allowed to lie about and serve as breeding ground for flies, mosquitoes and germs of the various fell diseases.

The principle of compost-making is to collect the vegetable and animal refuse into heaps or pits, inoculate these with some starter of organic origin such as cowdung, night soil, chicken manure, urine, earth scraped from the bottom of channels and drains, or inorganic nitrogenous compounds like Adco and salts, like ammonium sulphate, sodium nitrate, lime, etc. The bacteria and fungi acting under suitable moisture and aeration conditions break down the mass into fine humus which is the perennial source of soil fertility. The Chinese farmer has been an adept in this method since thousands of years. By converting every bit of organic waste available either on the farm or in the habitation into compost and by using it carefully in the field, he has been able to maintain a high fertility level of his soil throughout the ages inspite of intensive cultivation season after season.

Compost has received considerable attention in recent years from the agricultural chemists of many countries. A number of methods of making it have been evolved to suit the conditions of a particular case. Without going into the technicalities of the subject, the present article aims at describing the simplest of these methods, suited to Indian conditions and capable of being practised by the small farmer, the grower of vegetables, the orchardist and the nurseryman. The aim should be to equip each farm, nursery and vegetable garden with a battery of compost pits where all available material is converted into compost, thus making each unit self sufficient in its requirements of manure. The consequent increase in output from land will more than cover the present gap between the country's total food production and its total requirements.

A. Aerobic Methods.

1. **Fine texture compost: Quick method.** Dig a shallow pit 20 ft. long, 8 ft. broad and 2½ ft. deep at a suitable place not likely to be inundated during the rains. The length and breadth can vary with the daily supply of material to be dealt with. The earth dug out should be piled along 3 sides, leaving one of the longer edges flat. Collect the day's supply of cattle-dung and rubbish separately along the flat edge. The dung will include urine, chicken droppings and scrapings from the cattle shed, whereas the rubbish may be anything of organic origin from the dustbin, sweepings from the cattle shed, maize and *jowar* stubble, stalks of cotton, *arhar* and mustard, soiled straw, weeds, leaves of trees and bushes etc. Spread a 3-in. to 6-in. layer of rubbish at the bottom, leaving about 4 ft. space at one end vacant. On it give a 1-in. to 4-in. layer of cowdung etc. Repeat the layers like this, till the day's supply is exhausted taking care that the last layer consists of straw and rubbish. The material collected each day is treated in a similar manner. Every third or fourth day the layers are saturated with water. Care should, however, be taken not to add too much water as it might impede aeration and with it the beneficial activity of the microflora and fauna in the heap, especially in its lower layers. When the height of the material in the pit is 12 in. to 18 in. above ground level, give a final doze of water and cover the whole with a 4 in. to 6 in. layer of fine earth. Dig up a new pit and treat the material in the same manner. In actual practice a battery of pits should be dug for each house-hold or unit, on a semi-permanent basis.

After 7 to 8 weeks the first pit will be ready for turning. Do this with a showel or spade. Start at the end with 4 ft. empty space. Cut open the layers, and toss the manure against the empty end of the pit piling it up as the work proceeds, taking care to break up any lumps. By time the job is finished the pit will be filled and the empty 4 ft. space will be left at the opposite end. Sprinkle enough water on top to saturate the heap and cover it up again with earth. At the end of another 7 or 8 weeks the compost will be ready for use.

Cattle urine is generally not properly utilised although it has a high manural value. A practical way of doing this is to use waste straw, stubble, leaves of trees and pine needles etc. as cattle bedding. This can be replaced every 24 hours and as it sponges in most of the urine, it makes fine compost. The starters inoculate the basic raw materials with rotting micro-organisms and enrich the resulting compost in its nitrogenous content. In case cowdung etc. is not available in large quantities, the inoculation is conveniently done by turning it into paste; of course the compost may be comparatively very poor in nitrogen content, especially if raw material like *bagasse* has been used. Fine earth, scraped from the bottom of irrigation channels and drains, or soil rich in humus from beneath the trees, are generally rich in bacteria and fungi and may be used as starters.

2. **Compost making during rainy season.** The frequent addition of water can be avoided by filling the pits during the rains. Green weeds can also be utilised at this time of the year. The showers of rain supply the required moisture. Care should be taken that the empty space does not get filled up with rain water. The final heap should have a rounded top and the whole covered up carefully with 4 to 6 in. layer of earth. The turning should be done in the usual manner and the heap again covered up after sufficient quantity of water has soaked in.

3. **Rough textured compost.** A turning of the heap in the middle of the composting period results in fine powdery compost and the period is also considerably shortened. In case a turning is not considered practicable, the pit may be filled without leaving an empty space. The material will break down into a coarser texture compost in a period of 5-6 months.

4. **Composting in localities with a heavy rainfall.** Here, in order to avoid water logging, compost heaps should be prepared on high lying land on the surface of ground. The heaps may be 10 ft. to 15 ft. in length, 6 ft. to 9 ft. in breadth and not more than 5 ft. high. The heaps are built up in alternate layers as before ending with a rounded top well covered with a layer of earth so that rain water cannot soak in. The heaps are turned over after 7-8 weeks as in the first case and rebuilt. A battery of heaps can be had in one length leaving about 1 ft. space in between two heaps.

Water logging has often to be countered in the case of compost pits. The following devices may be used for this purpose:—

(1) Keep the floor of the pit slightly slanting lengthwise and leave a small space empty at the lower end. The surplus moisture accumulates here and can be easily baled out and thrown on top of the heap if necessary.

(2) Prepare ventilation channels sunk in the floor of the pit. These may be about 4 in. $\times$ 6 in. in cross section and loosely filled in with brick-bats, large stones, etc. or covered up with flat stones and tiles. They unite at the lower end and serve to drain out excess moisture and also to let in air. Where suitable topography is available, as in the hills or on embankments of village ponds etc., the ventilation channels may open out into the lower terrace.

(3) **Air vents on the top.** These can be easily made by thrusting a crowbar vertically down and moving the free end round in a circle.

B. Anaerobic or Hot Fermentation methods.

The aerobic methods described above involve much loss of nitrogen. Also in the case of municipal wastes where large quantities of night soil are utilised the initial rise of temperature is not maintained; the activity of the beneficial composting organisms is replaced by that of putrefactive organisms. The smell becomes offensive and the compost heap may become a breeding place for flies. The anaerobic or hot fermentation methods are especially suitable under such circumstances. The materials are allowed to undergo a brief initial aerobic fermentation when the temperature rises to a sufficient extent. They are then packed into air-tight cisterns and sealed. The composting process gets completed in about 3 to 4 months time. The following anaerobic composting method can be easily utilised by any farmer.

Dig a pit 10 feet in length, 6 feet in breadth and 6 feet in depth on a raised piece of ground, collecting the dug up earth on three sides. Fill it with alternate layers of basic material and the starter as usual. The filling up however should be accomplished gradually in 15 to 20 days time, thus allowing the initial aerobic decomposition process to start, which can be tested by thrusting a metal rod into the heap and feeling its temperature as the rod is taken out. Add just enough quantity of water to saturate the materials. The level of the finished heap should be raised 3 to 4 feet above ground level. Now seal it up with a thick layer of packed up earth, rounding up the top in the process. The dug earth comes in handy at this time and also protects the sides against rain water. The heap gradually sinks and in about 4 months time the compost will be ready for use. The method has been recently tried at the Forest Research Institute, Dehra Dun, with success.

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THE UNFAILING ELEPHANT GOD

BY SRI C. RAJAGOPALACHARI

(Rendered into English by Sri R. Chakravarti)

At day break Chinnappan and his son Mari started for the Senthamangalam Reserved Forest to collect firewood. They had no permit from the Forest Department, but what did that matter? Chinnappan had boundless faith in the elephant-faced God who was for-ever patiently sitting under the great tree on the tank bund and watching over the welfare of the villagers. Had He not been his saviour throughout his life? And to-day had he not brought Him a cocoanut? It was true that the cocoanut had been pilfered from his landlord's garden the previous day, but in this case, surely the end justified the means; was not the cocoanut to be offered to the Lord?

So they reached the tank and the presence of the Lord, and after his morning ablutions, Chinnappan reverently offered his prayers to the God—prayers which, it must be confessed, consisted mainly in urgent requests that the Merciful One would save them from detection by the patrolling Forest Guard. The cocoanut was duly halved; one half for the Lord—the other for father and son ! The boy finished his share in no time, and hungrily eyed the other half as it lay at the feet of the deity. Couldn't they eat that too? After all, as he knew quite well, only monkeys would benefit by that half. But Chinnappan rebuked the irreverent youngster, and sagely remarked that monkeys too were divine.

As they made their way carefully through the dense forest, following a path that he knew by experience was not frequented by the Forest Guard, Chinnappan began to think aloud. He possessed just three annas at the moment; a permit from the Forest Department would have cost him an anna and a half; well, if the Lord was with them to-day and they were not detected, all well and good; that would be one and a half annas saved. But if the Forest Guard did happen to see them...........? They could of course bribe him; but that would probably take all their three annas. Well, everything depended on luck—and favour of Ganesh.

These speculations did not, however, prevent Chinnappan from returning to practical politics. He cautioned his son. If the Forest Guard caught them and demanded their permit, he would naively ask Mari to produce it, as though the permit was with him; Mari was to rummage among his clothes; and then lament that he had by mistake left the permit at home.

By noon they had finished their job, and with a great bundle of firewood they returned to the tank bund. Depositing the bundle and their tools in a sheltered spot, they bathed, and then ate the food they had brought with them, but not before offering a thousand thanks to the Lord, and beseeching Him once again for the successful completion of their day's campaign.

It was a hot day, and the morning's work had tired the little boy. He soon fell asleep. He dreamt that he suddenly caught sight of the Forest Guard, and the latter caught sight of him. He ran through the forest to escape. The Guard gave him chase and was gaining on him when suddenly the Lord Ganesh appeared and seizing him by the hand led him in an instant to the Goddess Amman whom He bid hide the boy safe from his pursuer. But Mari was not without suspicion; would not the Forest Guard find him even there and arrest him? The Goddess, however, reassured him; if the Guard approached their sanctuary he would suffer for it; with her Mari was safe. Then she gave Mari cocoanuts upon which to feast. Just as he put a particularly delicious bit into his mouth, someone jerked him violently by the shoulder, and the Goddess disappeared.

He was awake. The Forest Guard was there, right before him, in the flesh. This time it was no dream. "Thieves and rogues, where is your permit?" he shouted. "We are no thieves, master. We have a permit. Come on, Mari, show him the permit.". The drama they had rehearsed earlier in the day was now enacted. The Forest Guard, however, was too experienced in this sort of affair to be taken in by their story. Chinnappan was not the first thief that he had caught. Either they produce the permit or go with him to the forest office, with all their incriminating evidence of firewood, axe and rope. A case would of course be made out against them, and they would spend the next six months in jail.

Chinnappan now tried other tactics. He admitted his mistake. But would the Forest

Guard please accept a little gift—unfortunately three annas was all they had with them—and let them go? Our Forest Guard was a little conscious of the new era in which he was living —Independent India, where acceptance of bribes was a thing of the past. Amusedly, yet firmly, he reminded Chinnappan and his son of this fact.

Chinnappan had one other string to his bow. In piteous tones he acknowledged again that he had indeed committed a "crime"; the very thought of it was now distressing to him. But if he went to jail for it, who would take care of his wife and children? He had a large family and but small means. Would not the Forest Guard take pity on him? Was he also not a father? And would not the Lord Ganesh bless him and his family if he was merciful to this poor wretch and his innocent son?

The Forest Guard, though conscientious, was also human. He relented, and after administering half a dozen warning not to repeat the offence, and after extracting an equal number of earnest promises from the two that they would never, never, in all their life again go anywhere near the Government Forests without first obtaining a permit, he issued a permit in their favour for the legitimate fee of one and half annas, and let them go.

So they were free. Dividing their precious firewood into two loads, the larger for Chinnappan and a little one for Mari, they went joyfully home. Chinnappan related their adventures to his wife, pointing out that the Lord Ganesh, the Saviour, had once again been with him, and Mari added emphatically that the Forest Guard was a good man.

In Rasipuram Bazaar that evening they sold the firewood, the large bundle for six annas and the smaller for two and a half. On the way back, Chinnappan could not resist the temptation to halt for a few minutes at the site previously occupied by the toddy shop. All that now remained of the once prosperous place in these days of Prohibition, was a dilapidated mud wall. Chinnappan eyed this for a few minutes, thinking many things.

Back at home he deposited his earnings with his wife. It was now her turn to thank the Lord Ganesh, the Saviour. She thought, "If the toddy shop were still there, where would this dangerously earned money have gone, and how should I have bought to-morrow's food?"

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SCOPE OF FORESTRY DEVELOPMENT in EAST PUNJAB, PATIALA AND THE EAST PUNJAB STATES UNION

BY SARDAR JALMEJA SINGH MAJITHIA, P.F.S., EAST PUNJAB

The territory under consideration lies on the plains as well as in the hills. Various kinds of soils, resulting from different geological formations are therefore met with. The soil in the plains, being alluvium, is rich. The rainfall varies from very few inches in desert regions to somewhere near 80 inches in the hills, *i.e.*, the plains have an arid climate while the hills have sufficient rainfall. Part of the plains region is canal—or lift irrigated but the greater part is under *barani* cultivation or is only poor grazing ground.

2. **Topography.** The elevation varies from high altitudes in the hills down to a few hundred feet in the plains. The high hills are covered with high forests of firs, deodar (*Cedrus deodara*) and *kail* (*Pinus excelsa*). The low hills are covered with *chil* (*Pinus longifolia*), oak and scrub. The sand-rocks and the earth beds of the Siwaliks are cut up into a network of deep and narrow ravines and these hills, therefore, bear scanty vegetation. The land slopes gradually from the foot of the hills down to the plains, draining the cultivation into *chos* and streams through numerous *gullies*. The plains have a rich alluvial soil. The plains finally touch the desert on the Southern side.

3. The coniferous trees, viz., deodar, *kail chil*, *rai* (*Picea morinda*) provide timber to the plains markets. Resin is extracted from *chil* trees. The scrub forests of the low hills provide fuel and grazing to the local inhabitants only. Cottage and other industries like fibre making, drug-manufacture and honey production can, however, be set up. These scrub areas have a great future, if they can be developed into forests composed of trees of commercial and industrial value. Fairly dense vegetation is necessary on the hills in order to tone up the climate, to attract rainfall, to absorb and regulate the flow of water into springs and rivers and to protect the soil from denudation.

4. **Evidence of deterioration by erosion.** Destruction of the plant cover increases the run off from the land surface. It shortens the period of high floods, but increases river potentiality to do damage. Water supply in the dry season decreases. Forests grow slowly and the soil improves only steadily, but their misuse or neglect leads to their total or partial loss in a short time. Soil is being mostly lost by the action of water and in some places by wind. Excepting the irrigated fields which are generally level, top soil is being eroded every year all over the province. This denudation of the rich top soil is rendering the land unfit for agriculture. There are vast tracts of this type where this sheet-erosion is insidiously going on. Tons of silt are being washed down by rain every year. An acre of land sometimes loses over a 100 tons of top soil. Sheet erosion is wide spread, not only on sloping ground but on flat ground also where grazing is heavy or there is no ground cover. It is even going on in heavily grazed lands under forest. Gully erosion in *darar* lands is apparent and here the fields are being rapidly destroyed. Bank erosion is progressing along streams, and sometimes it produces misery by destroying villages and cultivation. Statistics indicate that an area of 75 square miles, under *chos* in 1852, owing to neglect, increased to 700 square miles in 1939 in Hoshiarpur district. Wind erosion is going on over sandy soils subject to visitation of wind storms.

5. **Effects of erosion.** There are high floods that cause devastation by eroding cultivated lands, by spoiling the cultivation along the *chos* and rivers. The periodical devastations by rivers and *chos* are on the increase as the down-coming sand raises the stream beds. The constant denudation of the rich top soil is impoverishing the land at a fast pace. Longer periods of drought occur on account of less equable flow of water in rivers and streams. There is, therefore, less water available for agriculture and irrigation supplies are uncertain. Wells dry up as the water table is gradually falling on account of lack of vegetation cover. Thus, crop yield is on the wane. Erosion is also reducing the cultivated area by cutting it up into *darar* (gullies), covering it with sand or reducing it to the under-lying hard pan rock.

6. **Policy.** A policy is always necessary in order to promote the welfare of the agricultural masses. Agriculture can be greatly

improved by the practice of soil conservation which is, in fact, conservation of moisture and regulation of the water supply. It will be necessary to foster self-help amongst the farmers in order to remove the impression that everything must be done by the State. Remote forests will, however, be worked for revenue. The value of scrub forests will be enhanced by growing more valuable species. Fuel reserves will be conserved as well as built up in new places. Industries will have to be developed. Pasturage will be provided for needy cattle, till their masters take to stall-feeding them. Catchment areas of rivers will have to be kept well wooded in order to promote an equable flow of water into the canals. Land stricken by *chos* will have to be reclaimed and given back to agriculture. Erosion will have to be combatted. Fuel will have to be provided at the farmer's door so that he may divert the cowdung to his fields. Correct knowledge, backed by research, has to be disseminated to educated farmers. They can use this knowledge for good farming and soil conservation. Forests are a great national asset. They should cover 15-20% of the total land area. Regional Working Plans will have to be framed for them. Civil *rakhs* should be managed by the Forest Department.

7. **Land Survey** is very necessary to record as well as map the soil types, slopes, kinds and degrees of erosion and planning of land use. A committee consisting of an agricultural, a forest, a co-operative and a revenue officer could make this survey in a very useful manner. This survey needs the early attention of the administration. By determining the topography, soils, rainfall, vegetation cover, erosion, etc. land can be more or less classified as follows :—

(*a*) **Irrigated cultivation.** Here, from the forestry point of view, planting trees along water courses, and the edges of cultivation will have to be done.

(*b*) **Barani cultivation.** The fields will be levelled by terracing, *watt-bandi* with sills provided and retaining walls erected in order to absorb the rain water.

(*c*) **Hazardous cultivation.** Land along the banks of sandy *chos* and near the desert fringe will have to be provided with a shelter-belt of trees.

(*d*) **Pasture lands.** These will be managed by rotational closures, and fodder grasses will be increased.

(*e*) **Forests.** These will be managed on scientific lines, and will include high forest, scrub, irrigated plantations, wood-lands, *rakhs*, dried up *barani* lands, *darar* lands, fuel reserves, road, railway and canal avenues, etc.

(*f*) **Fruit orchards.**

(*g*) **Abadi lands** under villages and towns, wells and ponds etc.

8. **Objects of forest management.** In order to enrich the people their lands must be enriched and for this purpose forests can be so managed as to serve, more or less, the following objects :—

(*a*) **Afforestation.** Bare as well as under-stocked catchment areas will be fully stocked with vegetation, in order to promote an equable flow of water into rivers for the purpose of irrigation to prevent the transport of sand down to plains by *chos* to reduce flood intensity and to increase infiltration of rain water into the soil so as to raise sub-soil water etc. Unproductive *barani* lands can be enriched by putting them at first under tree crops.

(*b*) **Reclamation.** Erosion of *barani* lands can be reduced or prevented. Moisture conservation measures can be adopted. Soil fertility can be increased. *Cho* stricken lands can be reclaimed. *Chos* can be trained to prevent further destruction of cultivation. Shelter belt trees can be provided where necessary. Sloping lands will be levelled with machinery.

(*c*) **Fuel plantations.** Irrigated plantations and road, canal and railway avenue plantations will be set up for income. Village wood lands will be formed in order to provide fuel to the farmer at his door with a view to wean him from the habit of burning his cowdung which could then be very profitably used as farmyard manure to enrich the cultivation.

(*d*) **Pastures.** Pasture management will be developed into providing better grasses. The habit of stall feeding on grass cut from the closed areas will be inculcated in order to reduce the number of useless cattle. Pasture will be improved by rotational closures and by propagating better grasses.

(*e*) **Trade and Industry.** The forests will be run on profit lines. Subject to the satisfaction of local domestic needs, these forests will be managed for the following purposes :—

(1) to provide timber for the population,

(2) to provide fuel to the towns,

(3) to provide charcoal for gas-plants,

(4) to provide raw materials for paper, pencil, matches, sports, resin and turpentine, artificial silk and other big industries,

(5) to provide raw materials for cottage industries like rearing lac insects and silk worms, basket making, ply-wood, extraction of oils, dyes and tanning materials, etc.

(6) to establish pharmaceutical gardens and cultivate drug plants for *kuth karu, patish* digitalin, ephedrine, pyrethrum, castor oil, *chiraita*, santonine, podophyline, *rasaunt*, etc.

(7) to incidentally provide forest recreation by serving as camping grounds, picnic and sports areas, resorts, etc., which is likely to be in great demand, with the rapid development of the country and the speedier means of transport.

9. **Soil conservation.** Unrestricted fellings, grazing and browsing have denuded the low hills and the submontane regions of their top soil as well as forest humus found in the top soil. Absence of vegetation, which would have absorbed the rain water, results in spate of water and there is therefore practically no absorption of the valuable water *in situ*. This state of affairs has rendered the low hills infertile and resultant *chos* devastate the lands when they wander on to the alluvial plains. Subsoil water level is falling and wells are drying up. The extent of deterioration has depended on the nature of soil, slope and intensity of rainfall.

The remedy lies in combating the erosion and conserving the soil moisture. Regional Working Plans for the different catchment basins of main streams will be needed, which will prescribe and suggest the following: Strict closure to grazing and browsing results in marked improvement of forest growth; grasses and bushes come up naturally. Grazing by sheep, goats and camels will have to be stopped as they do a lot of damage by dislodging the soil and by browsing trees and scrubs to their extermination. Land value can be markedly increased by sowing and planting useful trees like *semal* (*Bombax malabaricum*), *khair*, (*Acacia catechu*), *kikar* (*Acacia arabica*) *shisham* (*Dalbergia sissoo*), etc., and useful grass like *bhabar* (*Ischaemum angustifolium*) used in paper manufacture. Grass cutting will, however, be allowed and there will thus be no hardship due to grazing closure. Contour trenching will be adopted where necessary in order to trap water for sowing or planting with economic species. *Gully* plugging with brushwood or cheap loose stone check-dams, notably, breaks the speed of the water and thus reduces the flood intensity down in the *chos*. Silt gets deposited behind these check-dams, and plants can be grown on this soil. Terracing and embanking fields in order to impound rain water is a very useful measure. Spillways will however be necessary in areas with a rainfall of over 80 in. *chos*. beds can re reclaimed by training *chos* into straighter and deeper channels. The *kacha* as well as *pacca belas* can be reclaimed by planting grasses and shrubs and when the land improves it can be made over to agriculture. Hundreds of fields have thus been built up in Hoshiarpur district.

10. **Cho training.** Rivers and streams in the alluvial soil are not stable, and their channels remain changing with their greatly varying discharge. Increased velocity at the bends erodes the banks and thereby reduces the area of cultivated and other lands. The floods also destroy the crops. It has been possible to train the streams (*chos*) in Hoshiarpur district and elsewhere, by revetting and guide spurs, into particular deep channels with the admirable result that vast areas along these banks have been reclaimed. There is a great scope of this land reclamation from the devastating *cho* action all over the country in the sub-montane region. These areas need placing immediately under closure. Complete closure is essential. Closure may have to be made even compulsory. It results in rapid establishment of *kana* and *kahi* grasses. *Chose* can be trained into particular channels by directional training including elimination of minor branches, reduction of curves, fixation of banks, removal of obstructive islands and establishment of dense plantations along the edges.

Reclaimed land being infertile for field crops, can be afforested with *kana, kahi* live hedges and later with *shisham*. *Bhabar* can also

be grown with advantage. Thus sandy wastes can be put to a profitable use which brings income. This land can be handed over for agriculture, after some time when leaf fall has rendered the soil fertile.

11. **Water logged areas** can be stocked with willows, *jaman* (*Eugenia jambolana*), etc.

12. **Mechanical reclamation.** The problem of soil deterioration and the increasing population demand the making of all available land more productive. Farm machinery, bull dozers, road graders, ditching ploughs, earth scoops will have to be employed to level the *barani* lands, so that they may absorb more moisture. There is no fear of this machinery ousting farm labour, as large tracts (fallows, culturable waste, parts of village forest lands, poor cultivation) will be opened out to more intensive soil working while these tracts are, at present, supporting only graziers or cultivators who cannot even eke out a living. These tracts, when eventually developed, would need more hand labour for the seasonal cultivation in order to yield a higher out-put of good crops per acre. Levelling the *barani* cultivation adds several inches to the rain water absorbed and on this absorption depends the welfare of the cultivated crops. Farming under arid conditions is already creating a tussle between the increasing population and the advancing desert conditions of these *barani* lands. The crops reaped are poor in quality as well as in quantity. Levelling the land and *watt-bandi* with a view to conserve the falling rainwater is very essential. Machinery can do this much more speedily and efficiently than hand labour will be able to do with *karaha* scoops, etc. Sub-soil tillage (with machinery) would be necessary to render the sub-soil absorptive. The sub-soil will then store sufficient moisture to ripen the winter crops.

It is imperative to better the peasant's lot if new industries have to develop because these industries would be in need of markets which can be found at home if the villagers' purchasing power be increased by developing the soil. Thus the slopy lands which are now barren with only a few mutilated *kikar* (*Acacia arabica*) trees completing the rather desolate picture or are infertile and produce only crops like *gram*, *taramira*, *chari* and *bajra* will, when levelled, eventually bear good food as well as cash crops.

13. **Grazing.** Forest grazing is a part of the problem of general grazing. The farmer is more interested in his working cattle. The forest, agriculture and revenue departments will have to find adequate grazing grounds for essential cattle. Rotational grazing schemes covering forest lands and waste lands will be the remedy in order to improve the quality and the quantity of grasses in the areas under rotational closure. These closures can be complete or partial, according to the nature of the locality and rainfall. Closures of parts of Hoshiarpur *shamlats* to grazing but permitting grass-cutting, reduced the horned cattle by 22% in 30 years. Only essential cattle were kept. Reduction in the number of cows and bullocks was 40% and increase in buffaloes 19%. Buffalo-cows are more amenable to stall feeding and also more profitable. Thus the closures result in better animal husbandry by replacing the less useful cattle by the better ones.

14. **Avenue-plantations.** Avenue trees along canals and roads stand in need of a scientific management to yield profit, by protecting the trees from mutilation and growing the maximum number of trees in the under-stocked as well as bare places. Waste lands along railways, roads and canals ought to produce fuel to their full extent.

15. **Farm-forestry.** There is great scope for the development of farm woodlots and for this some land can always be found around wells, paths, on the edges of fields and along water courses. Land not quite fit for agricultural crops can be put under trees. Certain percentage of *shamlat* can usually be put under wood, live-hedges of agave, *khair* (*Acacia catechu*) prickly pear, etc., that could serve the purpose of protection, and also prevent the incessant lopping of trees. Planting of trees for fuel and small timber is essential to village economy in order to make this produce available at the farmer's door. Wind breaks of tall timber trees like *shisham*, *jaman* and mango in orchards, would yield revenue, apart from saving the fruit fall by winds and storms. Tall trees like *shisham*, *jaman*, etc., can be grown on the edges of fields to eventually yield more profit, and this would over weigh the loss of crop yield due to shade. Thus intelligent use of all the available land in a village is needed. Farm-forestry is intimately connected with cowdung economy. Cowdung is used in all the villages, in place of firewood, for want of the alternative fuel which can be provided by farm-forestry. The valuable cowdung will then be diverted to the fields in order to nourish the top soil. Nor will the setting up of these

village plantations be costly, as it will involve only labour which should be available. Preparatory work like soil working, etc., can be done at any time when the farmer is free from work in his fields. Sowing and planting only has to be done at the proper time *i.e.*, at the beginning of monsoons or in spring, but this work it will take only a few days.

16. **Irrigated plantations.** They are a very valuable asset in arid regions. They are a source of revenue. They satisfy the local demand for fuel and wood for agricultural implements. They are a good fall-back-upon in times of famine and war. They supply fuel to towns. Now when the fuel position is becoming more and more acute, the formation of a few 10,000 acre plantations in the areas to be commanded by the Bhakra Dam irrigation project, is very essential.

17. **Nurseries.** Nurseries are essential in order to complete the extensive programmes of planting up areas with useful species. They should be opened with the least delay so that it may be possible to have transplants after 1 or 2 years. The size of the nurseries will depend upon the areas to be planted, species, time the plants have to remain the nursery etc. Roughly 1% of the plantable areas may be put under nurseries. Nurseries require good soil, water and manure. It is desirable to start them at or near an official's headquarters.

18. **Industrial forestry**. Accounts for the profit philosophy and for this the economic and the silvicultural aspects of forestry have to be synchronized with the object of continuous production of forest crops. Forestry planning therefore starts before the forests are felled or regenerated. Forest protection in all its phases has to be practised. Fire protection requires collection and study of information concerning fire-hazards, fire detection, communications, transport and methods of suppression. Insect damage is studied and controlled. Best land is usually given to agriculture and the poorer to forests, but still the forestry practice should be able to give 3% compound interest an outlay.

19 **Drug-plants.** Minor forest products can form a large source of revenue. Now that indigenous drugs will be used and because they will be manufactured locally, drug yielding plants will have to be cultivated on a large scale, and there is great scope for their cultivation. Pharmaceutical gardens can be established in various places for cultivating medicinal herbs, shrubs and trees. The proportion of medicinal trees and shrubs in the woodlands can be increased according to a programme, independently or as post operations to fellings. Some of the drug plants that can economically be cultivated are belladona, *karu*, *patish*, *kuth*, santonine, pyrethrum digitalin ephedrine, castor oil, hyoscyamus *harar chiraita*, *kesar*, aloes, *brahmi* juniper, chamomilla, *anar*, podophyllum, glo, valleriana, *basuti*, *resaunt*, *bil ak*, ipomea, embelia, holarrhaena, Blantago, vrtivert etc. plants.

20. **Industries.** There is a great scope for factory development as well as for the development of cottage industries fed with forest produce ; some of them are mentioned below :—

Rosin and turpentine industry can be set up and resin can be extracted from *chil* trees. Manufacture of charcoal has a great future on account of shortage of petrol. Artificial silk can be manufactured from certain woods. Paper can be manufactured from *bhabar* grass, paper mulbery, fir trees, *nara*, Bhrogmites, etc. Fir, *siris*, *semal* Gmelina, Spondias, etc., yield good match wood. Silk worms can be reared on mulbery. *Semal*, *siris*, and Gmelina wood are good for packing cases. Pencil wood can be obtained from *semal* Cupressus toon, Kydia and willows. Mulberry, *darek*, Crotoneaster, Celtis, ash, Gmelina, bird-cherry and *imli* woods are suitable for sport materials. Walnut and maple wood is suitable for gun stocks and wood carving. *Shisham*, *toon*, horse-chestnut and several other timbers are good for furniture. Maple, laurel, *semal*, Betula, *jaman toon*, Gemelina and *sain*, (*Terminalia tomentosa*) woods are suitable for plywood. *Khair* wood yields *katha*. Lac insect can be reared on *ber* (*Zizyphus jujuba*) trees. Bamboos are made use of in sticks, carts, tent poles, etc. Fibre for cord and strings can be obtained from Sterculia, Agave, Helictres, Grewia, Spatholobus, Bauhinia, *sandan*, *ak*, etc. Flosses for pillows, *razais* and cushions can be obtained from *semal*, *ak*, willows, Eriodendron, Cochlospermum, etc. Tall and coarse grasses can be used in thatching huts. Oils can be extracted from martini, lemon, citronella and ginger grasses. Dyes can be extracted from the wood, bark, flowers, roots or leaves of *dhak kamila* Woodfordia, Nyctanthus, Michelia, Berberis, Punica and Symplocos plants. Bark, leaves or fruit of

kikar amaltas woodfordia, sal, *arjun* oaks, *imli, harar, bahera ber,* Anogeissus, *amla, mehndi* and Rhus plants yield tanning material. Baskets can be made of mulberry, willows, *pilchi*, etc. Fodder grasses can be made into hay and baled for export. Acacia and jhingan trees yield the commercial gums. *Mehndi* is a toilet plant. There are vast areas at present, under scrub and it is possible to systematically replace them by these species of great economic value.

21. **Recreation.** Forests provide ample ground for recreation, and this phase has a great likelihood of developing in the future, with the rapid increase of improved and speedier means of transport. This recreation will provide to the people outdoor activities of the leisure hours during week ends and/or short holidays. Recreational planning would eventually be necessary to provide for and maintain camping grounds, picnic spots, sports grounds, spots of scenic beauty, etc.

22. **Research.** Timber research is necessary to ascertain the most efficient and economic utilisation of timber and this will involve using timber of the best species for special purposes. These uses will be based on the structural properties of wood, moisture contents, bending properties, hardness, compactness, etc. Best methods of treating non-durable woods for making them resistant to decay will be ascertained. Methods of seasoning will be developed. Research will also continue to be made to find out the best methods of storing and sowing seed, planting, tending, felling and regeneration, and it will be extended to species not dealt with so far.

23. **Propaganda.** Dissemination of information is necessary in order to apprise the public of the uses and benifits of forests. Their co-operation is necessary in conserving and managing the forests. Agriculture and forestry are interdependent. In fact, forestry is a hand-maid to agriculture for the economic well-being of the farmer. The duties and functions of Forest Officers include propaganda making to prepare the villager's mind for co-operation, and for this the villagers must be educated to recognise the evils of fire, overgrazing, illicit fellings, etc. In short, soil and trees-sense has to be inculcated in the villager so that he may find his friends in the forest and the forester and extract the maximum benefit out of his land.

24. **Conclusion.** There is a great scope for forestry development. A rapid land survey and a policy are necessary. Every bit of land must be put to proper use. There should be no waste land. Animal husbandry has to be improved. *Cho* stricken land can be reclaimed. Infertile soil can be made fertile by soil conservation methods. Fuel can be grown at the farmer's door to divert the cow-dung, now being burnt, to his fields. Machinery can speedily level irregular land surface, when there will be much more absorption of rain water, and this will give higher yields of winter crops. There is great scope for establishing pharmaceutical gardens for the manufacture of drugs. Development measures to produce raw material for large industrial plants manufacturing paper, pencils, artificial silk, rosin and turpentine, sports goods, art-silk yarn, etc., can be taken in hand. Numerous cottage industries can be developed. Forests can go a very long way to the uplift of the masses by catering to their needs and usefully employ all persons by providing them employment.

LETTERS TO THE EDITOR

THE SHIFTING SANDS
CIRCARS' CLIMATE RAPIDLY LOSING ITS SERENITY

By P.V.C. Rao, Graduate, I.E.E., M.I.E.T. (London),
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A Circars' dweller often views the prospect of a change to the Ceded Districts with consternation and dismay. As he travels from Bezwada along the Marmagoa line or across to Raichur in the interior of the Cuddapah district, the rapid transition from the coastal belt is keenly felt. The refreshing waiting rooms of the railway stations vanish and the refreshment stalls appeal little to the hungry traveller. Water taps are few and far between and the water hawkers will have hectic time with the little buckets that they can muster. The blazing sun throttles the passenger and the dust-gales swing the moving train. The experience is really exasperating to a traveller of lesser fray.

When at last he finds himself located in one of the district or taluq places, and fights his way through the pursuit for a living accommodation, he and his family will be confronted with the daily household routine as so many problems of serious import. The purchasing power of his earnings suddenly goes down, and even if he is prepared to be a spend-thrift, he rarely gets even the bare necessities of life. He will have to look after water with greater care and regard than for petrol or any other rationed stuff. The scorching heat, the uncomfortable dwelling, the water scarcity, and the starving stomach are the repelling prospects that confront him and his family. Whether he is a Government employee or a private trader, he begins to regard the period of his stay in these districts as the accursed part of his span of life.

The present plight of the Ceded districts has been the legacy of an age-long denudation of forests, and the resultant erosion of the land through water and wind. The rainfall dwindled and the unharnessed forces of even the little rain that occurs repeat the cycle of erosion and leave more and more barren slopes. The sun scorches the earth and evaporates the little water that collects in the wells, the ponds and the creeks. Pockets of sand-dunes are formed and the vicious circle of soil erosion adds to the decay and devastation year in and year out.

A close study of the transformation that is slowly overtaking the Circars, would reveal to us that the history of the Ceded districts is slowly being re-enacted in the Circars. It is the beginning of a devastating cycle which, if unchecked, will slowly engulf and emasculate the rich coastal belt. The manifestations of this vicious process are apparent in the denuded areas of Nellore, Guntur, Krishna and Vizag districts. The hunt for cash crops is eating away the fertility of the lands and the intake of fresh fields under cover of grass and shrubs for cultivation is putting an end to the last vestige of covered fields. The blazing climate of Bezwada and Guntur is obviously due to the barren hillocks all around. Similar is the case with Vizag, notwithstanding the fact that it is a sea-port. Tobacco has taken toll of Guntur which is still passing muster as a surplus district, thanks to the Official statistics, and the disease is rapidly spreading to the West and East Godavary districts. The virginia tobacco is molesting the virgin land for food. Likewise, cotton and groundnut are sweeping the face of the Vizag district. The tobacco trade is the monopoly of a few British and Jewish cartels. We allow our lands to decay in order that they may produce the raw materials for the foreign factories, and at the same time we buy our food grains at exhorbitant prices from foreign countries. Should we allow ourselves to be fooled in this way even after we have attained independence ? It is something like killing the goose that lays the golden egg.

Let us save the Circars from the menace of erosion and the consequent repelling repercussions that obliterated the face of the Ceded districts. The first and foremost thing is to grow utility forests on the denuded slopes near all the important towns. All the uncultivable waste lands should be brought under afforestation and grass lands. The patches of cultivable wastes should be contour-terraced

and cultivated. The contour-trenched and afforested slopes together with the terraced fields arrest erosion, hold rain water where it falls and allow it to sink to the subsoil, and offer a permanent solution to the drinking water supply problem.

The sands are slowly shifting from the ravaged Deccan plains to the once cool coastal belt of the Circars, and let us open our eyes and undertake immediate preventive steps before the shifting sands choke our nostrils and blind our senses.

THE RIVER IN SPATE
(Shallowing beds of Godavary and Krishna)

By P.V.C. RAO, Graduate, I.E.E., M.I.E.T. (London),
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When the river is in floods, it betrays its origin in the tiny mountain streams. The glaciers in the Himalayas feed the Ganga, the Jamuna and the Brahmaputra. The veteran mountaineers can often glide over these glaciers and the tourists will hardly believe that these silver lines are the birth pangs of the surging rivers. The scenic beauty of the mountain tops and the gliding streams bear little testimony to the heart-rending scenes and the despairing devastation wrought by the roaring rivers in spate. When the menacing tidal waves engulf villages and towns and obliterate life and property, the solicitous islands and sand patches sprinkled on its bed stand in striking contrast and hardly reflect the venomous reactions of the rivers in spate.

The Godavary takes its birth in a tiny Nasik lake and flows through a terrain of variegated hue. Many a village grew on its banks and it has taken in a number of rivulets. Nevertheless, it became useful only at the fag end of its journey to the sea. As it emerges through the gorgeous Papi hills, it thunders down its lonely dam at Dowleswaram, and on its onward journey to the sea, it engulfs vast extents of low lying lands. The suspended lot that flows with the waves includes a variety of woods shrubs and even wild beasts from the forests under denudation. The heavy load of silt in suspension gives the river the appearance of a rural swamp churned by the pigs. The hill sides in the Bhadrachalam agency offer a veritable mine of silt-laden streams to merge in the river flow, and the gullied creeks, the molten sands, the road-side ditches, the urban and rural sewage, and the bank-cutting contribute a good lot of silt that goes in suspension to the river.

When the floods recede, a number of tiny islands and sand-patches are formed in the bed of the river and vast plains of sand stretch the river banks two miles along the bed. These tiny islands formed by the cream of the soil washed from the slopes and the food-producing fields are auctioned every year for the growth of odds by the Government. The system is analogous to the burning of the house in order to trade in the resultant coal. If Cocanada port is incapable of being developed as a major port on the East Coast, it is not a little due to the tons of sediment that the river Godavary and its numerous tributaries deposit in the sea every year.

Perhaps the Public Works Department will furnish us statistics to show that the reservoir has been steadily losing its capacity by sedimentation. It is presumed that the designers of the new Ramapadasagar Project have taken into account the effect of sedimentation on the capacity of the existing reservoir with the advent of another high dam upstream. It is but in the fitness of things that the efficiency of the existing system of irrigation should in no way be impaired, when the new project comes into being, as a result of the critical areas of the watershed left unprotected. Investigations will have to be undertaken for a detailed survey of the critical areas so as to evolve overall soil and moisture conservation operations on the watershed. The river should necessarily be developed as a multi-purpose project. If effective steps for the arrest of further migration of the soil from the fields and the slopes to the coastal belt at the mouth of the river are undertaken forthwith, it should not be difficult to reclaim and develop the Cocanada port in less than a decade.

The plight of the Krishna is still worse than that of its sister Godavary. Krishna takes its roots in the Western Ghats and drives its weary way through the sand-dunes of the Deccan plateau. The Bombay, Carnatic could make little use of the river as its bed is far lower in level than the surrounding fields which are mostly cut up and undulating. Even though it compares favourably in volume with the Godavary, its condition is still worse as it takes with it part of the erosion debris of the Deccan. The withering floods rapidly give way to shallow beds which render the river look like a tiny stream during summer months. If the full potentialities of the river are to be utilised, it is essential to make detailed studies of sedimentation in order to reduce its menacing effect by the application of effective soil and moisture conservation measures on its watershed.

In the American technique of river development, soil conservation constitutes an integral part and it is highly important that our project developmental schemes should also be integrated with wide-spread soil conservation operations for the dual purpose of sedimentation arrest and effective land management.

EXTRACTS

PLANT GROWTH REGULATORS AS SELECTIVE WEEDKILLERS.

By E. Holmes, M.Sc., F.R.I.C., Plant Protection Ltd.

From "World Crops"

A tremendous amount of research and development work has gone into the discovery, production and use of weedkillers in the past half-century. In the earlier stage, botanists and farmers experimented tentatively with standard available chemicals, but now-a-days large programmes of work are in progress at research institutions and in the laboratories of chemical firms with the object of discovering new and better chemical compounds with a wide range of specific effects. Progress has been particularly rapid during the past decade, during which British workers discovered the so-called hormone or plant growth regulator types of weedkiller.

The position is reviewed in the following authoritative article.

Any plant growing in the wrong place is a weed. Consequently any plant, be it crop plant or useless plant, growing on paths, roads or railway tracks is a weed. The most serious weed of railway tracks in Australia is wheat. We therefore need chemicals that will kill all forms of plant life, in other words general weedkillers.

Similarly, almost any plant other than the crop plant growing in that crop is a weed. There are exceptions, of course, such as necessary shade trees in some tropical crops, of green cover crops to stop soil erosion. Weeds in growing crops compete for soil moisture, plant food and light, thereby reducing yields quite markedly in many cases. Until comparatively recently, these weeds have been dealt with solely by hand pulling or mechanical hoeing, but with the general world increase in labour costs and shortage of labour, a demand has arisen for chemicals that will kill our weeds without serious damage to the crop. These are known as selective weedkillers.

General and selective weedkillers.

The general weedkillers cover a very wide range of chemicals those usually used being based on sodium arsenite, coal-tar emulsions and sodium chlorate. All have disadvantages. The arsenicals are extremely poisonous ; the coal-tar emulsions are caustic and not very efficient, whilst the chlorates are very efficient, but under the same conditions involve fire hazards. Still other products which have been used for the same purpose are borax, common salt and, not so well-known, the sodium and ammonium salts of the thiocyanates and the sulphamates. The sulphamates have been developed in the U.S. in the last decade chiefly because they are specially effective against poison ivy.

The main interest of the agriculturist is in selective weedkillers which, at an economic cost, will kill our damaging weeds without appreciable harm to crop plants. Early in the century it was found that if cereal crops were dusted with the fertilisers kainit or calcium

cynamide, or if they were sprayed with dilute solutions of copper sulphate, many of the broad-leaved weeds were killed without any very serious effects on the cereals. In 1911, Rabate in France demonstrated that dilute solutions of sulphuric acid would similarly kill our broad-leaved weeds such as the charlocks without appreciable damage to the crop. In 1933, again in France, it was discovered that the chemical dinitro-orthocresol (D.N.C.) was equally effective against a rather wider range of weeds and did comparatively little crop damage. It was introduced to England shortly afterwards and to the U.S. about 1937.

In quite recent years, a number of derivatives of D.N.C., the sodium and ammonium salts and a number of compounds such as dinitro-secondary butyl-phenol have emerged as very effective weedkillers in a number of special directions. Unfortunately they are nearly all rather poisonous and require careful handling.

Many of the above chemicals act selectively because of physical differences between weeds and crop plants. Sulphuric acid sprays, for example, are retained on the broad and sometimes hairy leaves of a number of weeds in cereals and kill the weeds by direct corrosive action. On the other hand, the same spray runs down the vertical, smooth leaves of the cereals, doing no damage except possibly to the unimportant outer leaves.

Plant growth regulators.

To understand the development of the so-called hormone weedkillers we must go back to an original observation made by Darwin about 1880. He grew seeds of the grass *Phalaris canariensis* in the dark and found, as expected, that they sent up a vertical first shoot. When, however, light was introduced from one side only, the shoot bent towards the light. He demonstrated the same effect with oat coleoptiles (first shoots). If the tip of the shoot in either case was removed before exposure to light, no bending occurred.

A series of similar observations was made by a number of research workers in the next 50 years. They eventually led to the belief that something is produced in the growing tip of the plant which, under some conditions, could influence the rate of cell growth in that plant. Thus, if this ' something ' were caused by light to travel down the side of the coleoptile away from the light, and caused elongation of the cells on that side, obviously the coleoptile had to bend towards the light.

Around 1930, the organic chemists decided to take a hand in the work and, when it was discovered that these ' somethings ' also occurred in urine, they attempted to isolate them in order to determine their constitution. In 1933 two chemicals, plant growth regulators, were discovered and called auxin-a and auxin-b but there is now some doubt whether the constitutions assigned to them are correct. Whatever the truth, in 1934 a further growth regulator was discovered, called hetero-auxin and identified as beta-indolyl acetic acid. This is capable of easy synthesis in the laboratory.

Although these chemicals were all produced from urine they have since been isolated from plants. Their extreme activity is illustrated by the fact that 1 mg. (one 28,000th of an ounce) of auxin-a is enough to cause a bending of 10° in 50,000,000 oat coleoptiles !

Plant growth regulators have found practical application in quite a number of ways; in promoting the more rapid rooting of cuttings, for example of cacao, rubber and tea; for prevention of pre-harvest crop in fruits such as apples and pears, particularly in Australia and North America; for the parthenocarpic production of fruit (that is, causing fructification without fertilisation), especially of tomatoes under glass, and in the prevention of sprouting of potatoes.

Discovery of 'hormone' weedkillers.

In 1940, Dr. Templeman was carrying out a piece of work at the Jealott's Hill Agricultural Research Station of Imperial Chemical Industries in Berkshire, in an endeavour to discover whether the application of these products to seeds, cuttings or plants could produce an increase in total yield in the subsequent crop. His observations in this direction were substantially negative. In 1940, however, in the course of an experiment in which the sprayed soil containing oat and yellow charlock seeds, he noticed that alpha-naphthyl acetic acid, applied at rates around 10 to 25lb. per acre, entirely suppressed the emergence of the weeds without effect on the oats. This was followed by similar observations when sprayed. This, it is believed, was the first observation of the selective effect of this type of chemical on different plant species.

Alpha-naphthyl acetic acid at the above dosages was quite uneconomic from the farmers' point of view. In consequence a very considerable programme of experimental work was arranged with Dr. Sexton of the I.C.I. Dyestuffs Division Laboratories in Manchester. Following the examination of large numbers of synthetic chemicals, two particularly active compounds were discovered in 1941 and 1942, namely 2-methyl—4—cholorophenoxyacetic acid and the corresponding 2:4-dichlorophenoxyacetic acid. The sodium salt of the first of these has been named ' Methoxone ', whilst the second has become generally known as 2, 4-D. Prof. Blackman of Oxford has named them M.C.P.A. and D.C.P.A. respectively.

It is interesting to note that towards the end of 1942, Nutman, Thornton and Quastel had also reached the conclusion at Rothamsted that D.C.P.A. was selectively toxic to plants. The first American claim that this compound was a promising herbicide appeared in 1944. These initial discoveries by Dr. Templeman and the Rothamsted workers were communicated to the Agricultural Research Council in 1942 and, as a result, intensive comparative field trials of the relative merits of these compounds as against D.N.C. sulphuric acid, etc., were carried out by Prof. Blackman and a team of research workers during 1943-45. Large scale field operations began in 1945 and commercial development was initiated in the following year. To day many hundreds of thousands of acres are treated annually in Britain alone, whilst in the U.S. and Canada the corresponding area runs into millions of acres.

Mode of action.

These chemicals cause twisting and discolouration of the stems and leaves of weeds, they cause a thickening and weakening of the stems particularly at ground level, and they may cause the production of rootlets on aerial portions of the plants. Why this happens and the exact mechanism within the plant are not known, but the ultimate result is the death of the weed.

Time of application in relation to plant growth is not very important when dealing with such a susceptible weed as yellow charlock, which may be killed any time from its initial emergence right up to the flowering stage. On the other hand it is obviously best to kill the weed as early as competition of the weed for plant food and so on. Probably the best time to control sensitive weeds is when cereals are about 4 to 6 in. high and the weeds big enough to make sure the dust or spray hits them.

With other weeds, timing may be very important. For example, with ragwort and docks, the early seedling stage is very susceptible. On the other hand; excellent results have been obtained with ragwort, docks, thistles and some other perennials by application just before flowering. Doubtless these matters will be better understood when we know more about the inter-relationships of stag of growth, weather and timing of applications.

The action of these new types of weedkillers is comparatively slow. Results may be seen on sensitive weeds within 12 hours in really hot, dry weather, but it may be a week or several weeks before positive results show on the more resistant weeds. Weather conditions definitely affect speed or results, but not the ultimate result very much, provided rain does not occur within a few hours of the actual application. In general it may be said that best results on weeds and least adverse effects on crops are observed when both weeds and crops are growing vigorously.

Although there is some evidence that these plant growth regulators influence the potash metabolism of plants there is as yet little correlation between results and soil types.

Commercial products.

The number of commercial weedkillers based on these growth regulators is increasing extremely rapidly, particularly in America and this can be quite confusing. M.C.P.A. and D.C.P.A. are normally available as the water-soluble sodium salts or actual solutions and these are the two which have been mainly used so far in England. In the case of D.C.P.A., *i.e.*, 2, 4-D, the solubility of the sodium salt is rather low, so that means are sometimes sought to increase this property. One easy way is to convert it to what the chemist calls an amine salt and perhaps the most popular is the di- or tri-ethanolamine salt. In addition, and again in America, a great deal of experimental work and publication has taken place on the esters of 2, 4-D, that is, combinations of the 2, 4-D acid with various alcohols. It may therefore be useful to review the comparative efficiencies of these different types of product.

In general the sodium salts are cheapest as weedkillers and least damaging to the crop. It was earlier claimed that whilst the esters were more expensive per pound of active material they were very much more efficient, but that view has had to be modified. The accepted view in America now seems to be that, against really susceptible weeds, the sodium salts, amine salts and esters are very similar in action at equal rates of application in terms of acid equivalent. On the other hand, under difficult conditions such as low-volume spraying in areas with very low atmospheric humidity, the esters in soil solution salts in water. Similarly the ester in oil preparations show greater adhesion to weed foliage and, therefore, better results under heavy rainfall conditions.

It has to be admitted, that where slight damage is done to crop plants by these selective weedkillers, the sodium salts are much safer than the esters, whilst the amine salts appear to be intermediate in effect.

Quite recently, the esters of 2,4-D and of a new compound 2, 4, 5-T (2, 4, 5-trichlorophenoxyacetic acid) have given excellent results in clearing up many species of scrub bush, brambles and similar ' weeds '.

Arising from the mention of low-volume spraying, it should be pointed out that conventional sprayers use around 100 gal. of diluted spray per acre. The new low-volume techniques use amounts varying from about 5 to 25 gal. per acre. The quantities of actual weedkiller per acre are substantially the same in both cases.

Results on particular weeds.

It is quite impossible in an article of this kind to give any real picture of the tremendous possibilities of these new weedkillers in world-wide agriculture. A few indications, chosen largely at random, must suffice.

Dr. Templeman and others have shown that as little as 2 to 4 oz. of M.C.P.A. or 2, 4-D per acre, suitably diluted, can under research conditions give complete control of such a suseptible species of weed as yellow charlock (*Sinapis arvensis*). On the other hand it must be assumed that the average appliance on the average farm is not a very efficient machine. In consequence the amounts of active material normally recommended vary from 1/2 to about 2 lb. per acre, depending upon the type of machine and the weed concerned.

In Australia excellent results have been obtained against Noogoora burr (*Xanthium pungens*) and Bathurst burr (*X. spinosum*) in pasture with 1 lb. of M.C.P.A. or less. On white turnip (*Brassica campestris*) in cereals in Palestine complete weed control has followed similar applications.

A considerable amount of work has been done in many areas on weeds of sugarcane. For example M.C.P.A. and 2, 4-D, at dosages of ½ to 2½ lb. per acre have given substantially complete control of Spanish needle or black jack (*Bidens pilosa*) in the West Indies and East Africa ; of water-grass or listening Willie (*Commelina longicaulis*) in East Africa ; of Herbe Bol *Hydrocotyle bonariensis* in Mauritius ; of the castor bean plant (*Ricinus communis* and a number of witchweed (*Striga* spp.), the parasitic weed, in India.

In America great progress has been made in clearing up that pernicious weed, bindweed or morning glory (*Convolvulus* spp with 2, 4-D at about 2 lb. per acre in a wide variety of crops.

Finally in this brief summary must be mentioned water hyacinth (*Eichornia crassipes*). This scourge of waterways and irrigation tanks has been cleared very efficiently in India, Australia and elsewhere with one, occasionally two, applications to the foliage of either M.C.P.A. or 2, 4-D at 1 lb. per acre or less.

The effect of these selective weedkillers on undersown crops particularly clover is frequently questioned. The position is more complicated than originally thought. First experience was that young clover was usually killed out. It has since been found that undersown crops treated with 'hormone' weedkillers in the very early stages, *i.e.*, when the crop, weeds and clover are all small, will result in the destruction of the clover. If, however, application is delayed until there is a reasonable canopy of crop plants and weeds over the still small clover, then complete control of the weeds may be obtained without serious effect on the clover. The crop and weeds shelter the clover from the spray.

Hazards.

One or two specific hazards must be mentioned. On cereal crops there has seldom been any appreciable trouble except, perhaps, where applications have been made in the very early stages of growth, and particularly

on oats which may be damaged to a small extent in the seedling stage. Similarly, some varieties of barley and particularly the Scandinavian varieties such as Abed Kenia may occasionally have a small percentage of malformed ears as a result of treatment. Occasionally the flowering stem fails to emerge properly from the sheath. In general these malformations do not affect yield or the viability of the resulting grain.

Quite obviously it is necessary to take precautions to prevent these extremely active chemicals from finding their way on to susceptible crops and particularly on to such farm crops as sugar beet, beans and any of the *Brassicas*.

Financial considerations.

'Hormone' selective weedkillers are available as dusts and as sprays. Where a sprayer is available there is no doubt that the spray is more efficient and usually cheaper than a dust.

The obvious questions of any farmer new to this type of product are—how much do such applications cost and what are the benefits? Typical costs in Britain have varied, depending upon whether the farmer applies the product himself or utilises the services of a contractor, and upon the susceptibility of the main weeds, anything from 25s. to about 65s. per acre. More recently, however, it has been demonstrated that a large farmer doing his own work with a low-volume sprayer can control the same weeds for from 15 s. per acre or less to about 35s.

Under experimental conditions increases of crop yield as the result of such applications have varied from nothing, in the presence of very few weeds, to 150% increase in heavy infestations. With an average to bad infestation of weeds such that some form of weedkilling is called for, the average increase in cereal yield as a result of weedkilling is probably 20 to 25%. At today's prices in England this means an increased return for wheat, on land capable of an average yield, of £ 4 to £5 per acre.

There are other benefits. A clean crop involves less handling and easier drying in the stock, whilst fewer weed seeds are left to give trouble in the follow crop. Removal of weeds often removes alternative hosts for other pests.

Finally, there is now no doubt that these new weedkillers have come to stay.

Plastic welder-sealer

From "McGraw-Hill Digest".

Heating, welding, sealing, and melting of polyethylene, nylon, and polyvinyl chloride are possible with one tool—a flameless, electrical torch. Torch delivers hot air or gas up to 700° F. controlled temperature from 5-40 psi.—De Bell & Richardson, Inc.—Mod Plastics, Dec., p. 130.

Cures glue

(from "McGraw-Hill Digest").

Model R 1-A portable high-frequency wood-bonding machine can reduce fabrication time by as much as 70%. Completely cured bonds are produced within a few seconds on many jobs.—Pan-American Electronics, Inc.—Electronics, Dec., p. 205.

New air valve

(From "Cosgrove's Woodworkers' Report".)

A new addition to the "fingertip" type of Mead-Specialty Company's new three-way air valves has been announced. The valve has 3/8" pipe thread apertures for quick response when used with air cylinders up to 6" bore and operates by a very light touch on the handle-lever button. It is operated by means of a suitably located cam or trigger on the working machine.

The valve has mounting holes at top and sides to facilitate attachment to any machine. Of the popet type, there are no sliding closures to weat out. Hose nipples to take 3/8" I.D. and up to 3/4" O.D. air hose are included. For complete information on this new "ON" model, write for new catalog illustrating pneumatic air presses, valves, woodfeeders, and clamps to Mead Specialties Co., 4114 No. Knox Ave., Chicago 41, Ill., or circle number on card.

TWO LITTLE-KNOWN PLANTS FROM INDIA

By M. B. Raizada Systematic Botanist,

Forest Research Institute, Dehra Dun

The two species herein described were very recently collected by Dr. H.F. Mooney, C.I.E., I.F.S., Conservator of Forests, Sambalpur Circle, Orissa and sent to the writer for determination. One of these has been identified as *Alysicarpus gamblei* Schindler, a species collected only once from the Cuddapah district, Madras Presidency by Gamble and described by Schindler in Fedde, Repert. Spec. XXI (1925) 11, the other as *Pterocaulon redolens* (Forst. f.) F. Vill., which is a discovery of peculiar interest since it is the first record for India, its previous known distribution being from Burma to New Caledonia and Australia.

As recently pointed out by the writer (cf. *Journ. Bom. Nat. Hist. Soc.* Vol. 48. No. 4. Dec. 1949) the flora of Bihar and Orissa is still imperfectly known and the collections made by Dr. Mooney clearly indicate that the Eastern States, particularly the high lands of Kalahandi State, a remote tract of wild hill country situated in the extreme South-West of Orissa and adjoining the Eastern Ghats, of which they constitute the North-Western extremity, are of considerable interest botanically and provide much scope for further botanical exploration and research. It is true that many new species may not, perhaps, be discovered, although from Sonabera plateau alone, during the last year, two new species, viz., *Dimeria mooneyi* Raizada and *Oropetium villosulum* Stapf ex Bor have been collected and described, there is much to study in the distribution of plants; since it is in this southern table land that one would be inclined to look for a transition from the flora of the Northern to that of Southern India. There is no doubt that further exploration and research would bring to light a fairly large number of species having an affinity to the Southern Indian flora.

It may not be out of place to mention here another two interesting species collected by Mooney and hitherto not reported from Orissa viz., *Polygala elongata* Klein. & *Fuirena umbellata* Rottb., the former from Kapsela, 2,400 ft., Jashpur state (Mooney 1932) and the latter from Jambua in Pal Lahara.

Alysicarpus gamblei Schindler in Fedde, Repert. Spec. XXI (1925) 11; *A. bupleurifolius* var. *gracilis* Gamble, Fl. Madras 2(1918) 338. (Quoad spec. cit. e cuddapah; cet. excl.)

Apparently a perennial herb; stems many, erect, branching, glabrescent, up to 40 cm. long. Stipules glumaceous, lanceolate, acuminate, broad at the base, 5-6 mm. long. Leaves 1—foliolate, up to 30 mm. long, 6 mm. wide, petiolate, (petiole short about 2 mm. long) linear-elliptic, base acute, apex rounded, glabrous above, sparsely hairy below, prominently reticulate beneath; lateral nerves short. Racemes terminal, often leaf opposed, lax-flowered, elongate, up to 10 cm. long; rachis glabrous; bracts caducous, broadly ovate, shortly caudate, glumaceous, glabrous, up to 5 mm. long; pedicels thin, glabrous, 1—2 mm. long in flowers upto 5 mm. long and recurved in fruit. Calyx 5.5—6 mm. long, tube about 2 mm., teeth 4, unequal, one bigger than the rest with a truncated apex, all of them ciliated towards the upper portion. Corolla not or very slightly exerted (yellowish brown); standard broad, slightly notched at the apex; keel adhering to the wings. Pod sessile, sub-compressed cylindric, 3-5-jointed, somewhat reticulate, dusty pilose; segments 2-2.5 mm. long and 1-2 mm. wide.

Sonabera, 2,150 ft., Khariar, Sambalpur district, Orissa, 28-9-1949, H.F. Mooney 3646. On dry shallow sandy soil over quartzite.

So far known only from Tangelapenta, 450 m., Cuddapah district, Madras Presidency, collected by Gamble 21223, which is the type, in Herb. Calcutta.

Pterocaulon redolens (Forst. f.) F. Vill., Novis. App. 116 (1880); Merr. in Philip. Journ. SC. Bot. 12 (1917) 122 and in Enum. Philip. Plants 3(1923) 607; Kerr in Craib Fl. Siam Enum. 2(1936) 268; *P. cylindrostachyum* C.B. Clarke, Comp. Ind. 98(1876); HK. f. Fl. Br. Ind. 3(1881) 275; Gagnepan in F.I.C. 3(1924) 550 fig. 57; *Gnaphalium radolens* Forst. f. Prodr. (1786)91; *C. cylindrostachyum* Wall. Cat. (1831) No. 3931 nomen nudum; *Monenteles redolens* DC. Prodr. 5(1836) 455; Miq. Fl. Ind. Bat. 2(1857) 60.

A coarse erect perennial strongly scented herb., 2-3 ft. high (but at times attaining 6 ft.), softly tomentose, pubescent or woolly all over. Leaves alternate, obovate or oblanceolate, 1-2 in. long, woolly-tomentose on both surfaces, decurrent on the stem, crenate. Flowers in small (.15 in.) heterogamous heads, in ovoid terminal, peduncled clusters, white or pale purple. Outer flowers female, fertile, filiform truncate or 2-3-toothed; disk flowers hermaphrodite solitary or few, tubular, slender, 5 toothed usually sterile. Involucre ovoid or campanulate; bracts narrow, few seriate, inner deciduous with the flowers, outer shorter. Receptacle small, naked. Anther-bases sagittate; auricles connate, tailed; style-arms of hermaphrodite flowers filiform. Achenes small, terete or slightly compressed. Pappus scanty.

Ghorijhor, 800 ft., Gangpur, Orissa, 13-3-1950, H.F. Mooney 3748. A coarse strongly scented herb up to 6 ft. tall collected at the foot of dump from old disused manganese quarry.

Distribution :—Burma, Siam, Indo-China, Philippines, New-Caledonia (type) and Australia.

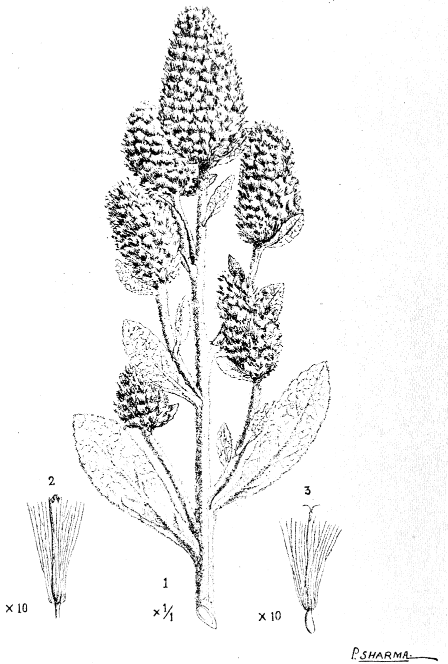
The following extra Indian specimens of this species have also been examined :—

Wall. Cat. 3931 and 2931; *Burma,* Herb. Griffith 3168; Prome, British Burma, Kurz 2263; Sagine, Burma, 7.1.1868, J. Anderson; Upper Burma, 1887, General Collett; Upper Burma, Dec. 1890, Abdul Hak; Makhaya Hill, Upper Burma, 18-12-1893, King's collector 69; *Minbu, Upper Burma,* 11-3-1903 *Ambert* and Gage; Saga, Southern Shan States, 1894, Abdul Khalil.

Benguet, Luzon, Philippines, A. Loher 3713.

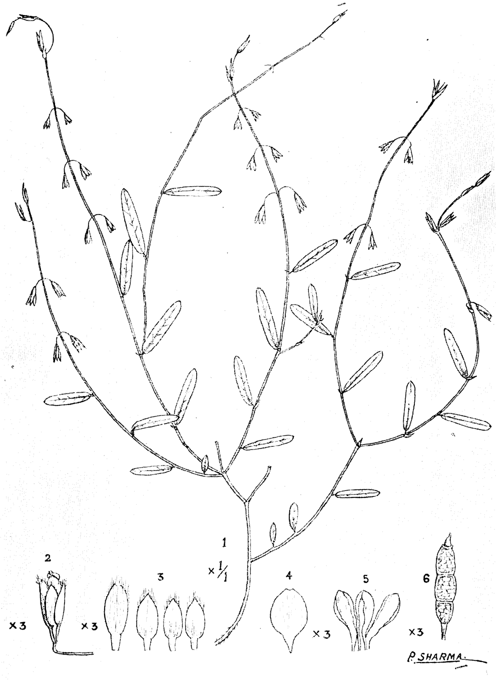
New Caledonia, Ex-Herb. G. Bonati, I. Franc 25.

Keppels Bay and Rockingham Bay, Melbourne, Australia, F. Von Mueller,



PTEROCAULON REDOLENS (Forst.f.) F. Vill.

1. A portion of stem with leaves & flowers. × 1/1
2. Hermaphrodite flower × 10
3. Female flower × 10



ALYSICARPUS GAMBLEI Schindl.

1.	Portion of the plant	× 1/1
2.	Flower	× 3.
3.	Calyx	× 3.
4.	Standard	× 3.
5.	Keel & wings	× 3.
6.	Pod	× 3.

A PRELIMINARY NOTE ON THE OCCURRENCE OF A SPECIES OF HELOPELTIS, (CAPSIDAE, RHYNCHOTA) ON NURSERY SEEDLINGS

By T.P. Viswanathan

A.C.F., Travancore Forest Service

SUMMARY

Both adults and nymphs of a species of *Helopeltis* very near *antonii* (Capisdae), have been recorded doing serious damage to the nursery seedlings of *Terminalia tomentosa* and *Lagerstroemia flos-reginae* at Parumpavoor. The food plants of *H. antonti sign.*, are *Anacardium occidentale*, *Bixa orellana*, *Cocao*, *Cinchona*, *Cinnamonum camphora*, *Erythrina Melia azadirachta*, *Swietenia*, tea, *Tephrosia*, and *Cucurbitaceae*. Their feeding causes distortions on the leaves and shoots. . Fish oil soap solution has been found effective in controlling the ling.

INTRODUCTION.

Though some members of the family Capsidae are predaceous a majority of them are plant-suckers. Many of them are now being recognised as of economic importance and capable of extensive and lasting damage if present in large numbers. The genus Helopeltis is of particular significance as it contains the famous mosquito-bug of tea—*H. theivora*. *H. antonii* is recorded as pest of *Anacardium occidentale*, *Melia* sp., *Swietenia*, etc.

In the present note another species of *Helopeltis* determined to be very near *H. antonii* has been described as causing widespread damage to nursery seedlings. It is suggested by the Forest Entomologist, Dehra Dun, that the species may probably be a new one.

Habit of the insect.

The adults are very flimsy and light insects. They are extremely sensitive to distrubances and take to flight at the slightest alarm. They are found feeding on tender leaves and shoots. It is said that the adults are night feeders, but observations show that feeding takes place with no less vigour during day time also. This is true of both adults and nymphs.

The nymphs are brownish in colour and would look like ants on casual observance. They are usually found moving about on the very tender leaves and shoots.

Nature of damage.

The species occurs on nursery seedlings of *Terminalia tomentosa* and *Lagerstroemia flos-reginae* but shows a definite partiality to the former. The nymphs are capable of as much damage as the adults. The insect sucks the sap from the tender leaf or shoot. Usually the feeding does not last for more than 150 seconds at the same spot. The insect then moves on to a different spot on the same leaf and after some time takes to a new leaf. In about 20 hours after feeding, a dark spot appears just around the puncture made on the leaf. The spot gradually widens out. The leaf-tissue in this region blackens and begins to dry up in about 3 days. In another day or two the blackened region shrivels up and drops down leaving a permanent hole of about 2 mm. diameter on the leaf. Several such holes may be found on the same leaf rendering it absolutely useless for the plant. If the leaf happens to be very tender the tendency is to curl up and get distorted and malformed. The affected shoot also shows the same blackening and, if very young, it dries up at the effected portion and eventually breaks away. If slightly older the shoot gets cracked and malformed.

Control.

No parasites or predators were observed except a few small spiders which occasionally catch a bug or two.

Hand picking and the use of net were found to be very difficult and laborious. The adults easily escape the net and the nymphs easily escape notice.

Fish-oil-soap solution was found effective and could be practised in the nursery.

In order to increase the potash content of the soil wood ash was sprinkled weekly on the nursery beds. After four such treatments the seedlings in some of the worst affected beds showed a remarkable recovery, while the seedlings on less affected beds showed greater resistance to further attack. May I suggest that this is another example to strengthen the advocacy of a severe burn of slash and debris prior to sowing or planting? I shall be thankful for any information regarding the occurrence of these bugs in other forest divisions in S. India.

DALBERGIA SISSOIDES, GRAHM

By Dr. K. Kadambi, F.R.I., Dehra Dun

Malabar blackwood (*Fam. Leguminosae*)

Local Names :—The tree is referred to by the same names as *Dalbergia latifolia* (Roxb.) Madras—Tam. *Thothagatti*. Mal. *Itti*, *eetti*, *vittii*, *karitti*, *eruputu* (Palghat) etc.

Trade :—The name 'Malabar Blackwood' was suggested for this species by T.F. Bourdillon (1).

DISTRIBUTION

Dalbergia sissoides is a South Indian tree found in the Western Ghats, from Mysore hills to the Pulneys and hills of Travancore up to 5,000 ft., (8) between latitudes 8° and 13°. Troup reports its occurrence in Malabar, the Palnis, Anamalais, Madura, Tinnavelly, Travancore and probably Coorg. Beddome states that the tree is common about the forests of the Coimbatore district, Palghat, the Annamalais, Madura and Tinnavelly. Hooker has mentioned of its occurrence in Nilgiris and of its doubtful occurrence in Java. J.S. Gamble has mentioned of a wood specimen of *D. latifolia* var. *sissoides* received from Mudumalai forest, S.E. Wyanaad, Nilgiris. Prain has mentioned of its occurrence in the Nilgiris, which he incorrectly supposes to be the northern most limit of this species, as well as in the Pulneys and in Travancore, and has sketched a specimen received from Kodaikanal. In his Flora of the Presidency of Madras, Gamble says the tree is found in Western Ghats, from the Mysore hills southward to the Pulneys and hills of Travancore, at rather low levels but occasionally up to 5,000 ft. (9) Within Mysore State the tree is occasionally found in Mysore district scattered in moist deciduous forests in the forehills of the Western Ghats adjoining the border of Coorg. Brandis says the tree is found in Wynaad, Palghat, Anamalais, Madura and Tinnavelly. (10)

LOCALITY AND HABIT.

Generally speaking *D. sissoides*, where it occurs, is an associate of *D. latifolia* in the moist deciduous forests of Southern India. It is found as a rule scattered, and from the information available, it appears to be less abundant than *D. latifolia* in the localities where they are found together. Bourdillon says that *D. sissoides* prefers the outer hill slopes while *D. latifolia* prefers the interior forests and consequently in some parts of the country the former is known as "*Poromalei*" or Blackwood of the outer hills while the latter is called "*Ulmalei*" or Blackwood of the inner hills. He also says that the latter tree ascends the hills to a greater height than the former and that he has seen *sissodies* at 2,000 ft. (1) Other authors (J.S. Gamble) state the tree occurs at rather low levels but goes occasionally up to 5,000 ft. which is also the highest altitude mentioned for *D. latifolia* (9) Chandrasekhara Iyer and Venkataramana Reddy have mentioned that the tree ascends the Travancore hills up to 5,000 ft. (8)

Dalbergia sissoides has been described to be a smaller tree than *D. latifolia* by various authors, notably by Troup, Beddome, Brandis and Bourdillon. Prain, in his excellent monograph on the species of ***Dalbergia*** however, described *D. sissoides* as an erect tree 40-70 ft. high, indicating that both the trees are able to attain almost similar dimensions (6).

Botanical description (Figs. 1 and 2) and DIFFERENTIATION between *D. latifolia and D. sissoides.*

J.D. Hooker places *sissoides* as a variety of *D. latifolia*. He differentiates *sissoides* from *latifolia* as follows :—

Leaflets rather narrower in proportion to their length and sometimes obtusely pointed [2] J.S. Gamble mentions of a certain specimen from Madumalai forest, S.E. Wyanaad, Nilgiris, where both flowers and leaves differed from those of *D. latifolia* (Roxb.) proper, and states that the specimen received is probably *D. latifolia* var. *sissoides* "which seems to deserve specific rank."[3] D. Brandis distinguishes *D. sissoides* (Grahm.) as follows :— "a remarkable tree, flowers 1/3 in. long, which requires further study. It generally flowers in July but has also been found to flower in March". He mentions that *D. emarginata* Roxb., Fl. Ind. iii 224, a large tree of the Andamans (probably on North Island) resembling *sissoo* in habit, with obovate emarginate leaflets, flowers 1/4 in. long, pure-white, fragrant, in axillary panicles generally congregated at the ends of branches, identified with *D. latifolia* in Flora of British India will probably prove a distinct species." [4] Beddone, while describing *Dalbergia latifolia* in his "Flora Sylvatica" about the year 1887, has made the following remarks :—

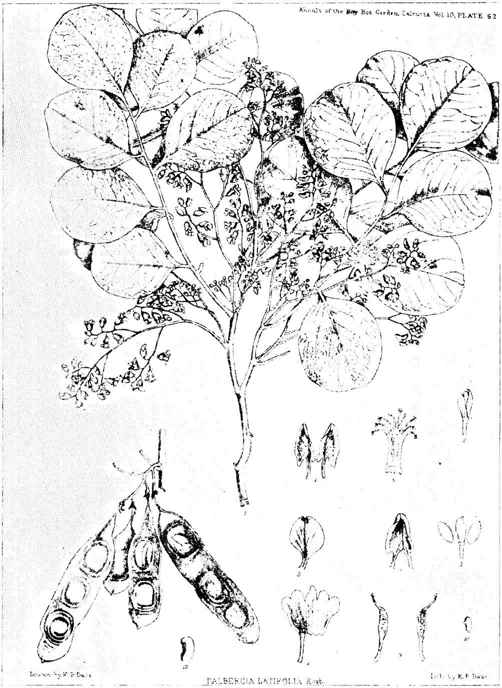
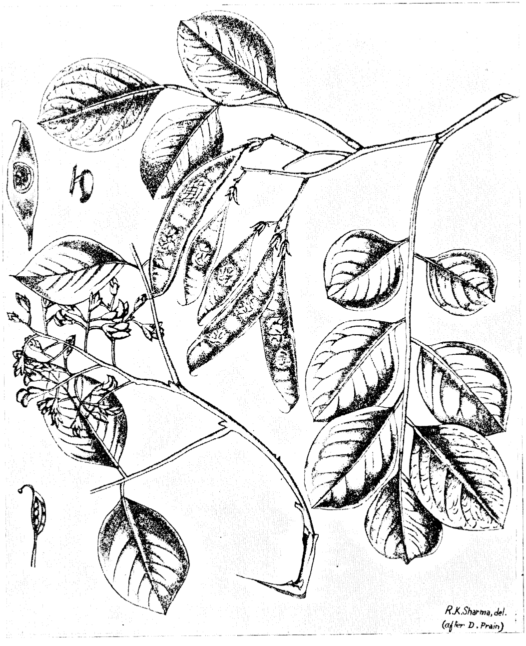

Annals of the Roy Bot Garden, Calcutta Vol. 10, PLATE 62
Drawn by K. P. Dass
DALBERGIA LATIFOLIA Roxb.
Lith by K. P. Dass

Fig. 1



DALBERGIA SISSOIDES GRAH.

FIG. 2

"The *Dalbergia sissoides* (Grahm.),.... is a smaller tree than *D. latifolia.* The wood is generally of redder colour, and the tree flowers in the rainy season (July), instead of the hot weather: it is always distinguished by the Palghat axemen as the *Eeruputu*, *D. latifolia* being called *Eetee* (Dr. Wright transposed these native names)." Beddome goes on to say that he cannot distinguish the two trees botanically, and adds that the flowers of *D. sissoides* are said to be longer and the leaves narrower, but these differences are not constant, and the same drawing might answer for either tree. He concludes that he looks upon *D. sissoides* as a mere variety of *D. latifolia.*[5] Bourdillon mentions that the above view was accepted for a long time, and all specimens of Rosewood from South India were called *D. latifolia.*

D. Prain in his monograph on the species of *Dalbergia* states the following of *D. sissoides* :—

This species is very nearly related to *D. latifolia* and may indeed be only a form of that tree; the distinctions, however, seem constant so far as India is concerned, and the wood-cutters of Southern India are said to distinguish the two by their habit and their timber and to give them different names."[6]

Bouridillon states that all carpenters and timber men distinguish two different woods called by the common name "*eettii*", and the samples brought invariably showed differences and could always be separated. One of them is known as "*Kar-eettii*" or dark blackwood, and the other "*vell-eettii*" or pale blackwood, and both are called "*thothagatti*" in Tamil and "*eetti*" and "*Veetti*" in Malayalam. He mentions that the darker wood or "*Kar-eetti*" is *D. latifolia* while the paler or "*veeleetti*" is *D. sissoides.* The following further distinguishing characters are furnished by Bourdillon :—

In young leaves the trees can be easily distinguished, even at a distance of quarter of a mile, but when in mature leaf they are not so distinguishable although they can always be separated without difficulty. The distinguishing characters of the two species as stated by Bourdillon are tabulated below :—

	D. latifola (Roxb.)	*D. sissoides* (Grahm).
Size :—	Attains larger sizes than *sissoides.*	— — —
Foliage :—	Foliage more compact; adult foliage looks always a dark blackish-green.	At first bright grass-green, never so dark as *D. latifolia* even when mature.
Leaves :—	Leaflets 3-7, generally 5; length of rachis 3-4 in., rarely 5 in., Petioles very short (under 1/4 in.) and slender; leaflets round; obtuse or emarginate, the outermost being the largest, the others decreasing successively in size. Young leaves very dark green, mature ones black-green, above and glaucous beneath.	Leaflets 5-10, generally 7, rachis 5-6 in. long; Petioles longer ($\frac{1}{4}$ $\frac{1}{3}$ in.) and stouter; leaflets pointed at both ends and all of the same size or nearly so; young leaves very bright green mature leaves lighter green than *D. latifolia* above and paler beneath, and also thicker and more glabrous.
Inflorescence :—	Flowers arranged in lateral panicles, axillary or from the axils of fallen leaves, rarely terminal.	Flowers slightly larger and terminal.
Flowering season :—	January-February.	July (Brandis), also March.
Fruit :—	— — —	Fruit narrower and less rounded at the apex (Prain.) Apex of fruit appears to end in a bristle (Bourdillon).
Timber :—	Ground colour purple; colour uniform, veined with black or	Ground colour purple; mixed with dark brown and never has any tint of

	red lines, in some cases a beautiful lake.	red in it; some samples resemble *Albizzias* in colour; wood stated to be harder, heavier, coarser and not capable of taking such good polish as *D. latifolia*; weight 52 lbs.; P. 721 (Bourdillon).
Habit :—	Prefers the interior forests and is therefore known in some parts of the country as "*Ulmalei*" or blackwood of the inner hills; ascends to a greater height than *D. sissoides*.	Prefers the outer slopes of hills and therefore known as "*Poromalai*" or blackwood of the outer hills, does not ascend hills to the same height; in hills at lower elevations *D. sissoides* predominates, but *latifolia* is also found.

Bourdillon concludes by saying the following :— " Now that these trees have been separated as true species, it would be convenient to give them different English names. *D. latifolia* is generally known as " Bombay rosewood. " for *D. sissoides* I would suggest the name of " Malabar blackwood. " (1)

D. Prain, in his excellent and authoritative monogram on the species of *Dalbergia* of South-Eastern Asia, has given the following exhaustive description of *D. sissoides* :—

" *Dalbergia sissoides* " Grah. in Wall. Cat. 5,876 (1832) :— an erect tree, 40-70 ft. high, with rather smooth bark and straight stem with numerous spreading branches; young shoots pendulous, sub-bifarious, glabrous.

Leaves 6-9 in. long; leaflets usually 7-8, rarely 5-6, obovate subacute, very rarely suborbicular obtuse, glabrous on both the surfaces, green above, glaucascent beneath, the distal usually the largest, 1.25-2 in. long, 1-1.75 in. wide, rachis 4-6 in. long, petioles 0.25 in. long. *Flowers* distinctly, pedicelled, in large terminal panicles with or without a few lateral in the axils of the upper leaves of the same season; pedicels 0.15-0.2 in. long; *Calyx* companulate, when young slightly puberulous and enclosed in two large very caducous membranous bracteoles; 5 toothed, the two upper teeth subconnate, the three lower subequal, oblong, obtuse or subacute, as long as the tube; *Corolla* white, petals all distinctly clawed, standard-limb entire with wavy margin; *Stamens* 9 or less often 10, in one bundle split along upper side; filaments free in their upper third, alternately somewhat shorter and longer *Ovary* glabrous, rather long-stipitate; style slender, stigma small; *Ovules* usually 4. *Pod* indehiscent, 1-3, rarely 4-seeded, very distinctly veined opposite the seeds, 2-3.25 in. long, 0.5 in wide, firmly coriaceous, gradually cuneate towards both style and stipe; *seed* much compressed, reniform, pale-brown, smooth but hardly shining, 0.35 in. long, 0.2 in wide. Prain says this species is very nearly related to *D. latifolia* and may indeed be only a form of that tree; the distinctions seem constant so far as India is concerned and the wood-cutters of South India are said to distinguish the two by their habit and their timber, and given them different names. The chief difference between *D. latifolia* and *D. sissoides* is as regards the position of the inflorescence. Both of them are reported from the Nilgiris and Prain thinks, though erroneously, that these hills may be the northernmost limit of *D. sissoides*. He calls the Java species of *Dalbergia* as *D. Javanica* Miq. and says the the Java specimens do not appear to agree either with *D. latifolia* of northern India or with *D. sissoides* or Southern India but, of the two they seem by their leaves and pods to agree better with *D. sissoides*. He thinks that the Southern India and Java trees are perhaps different geographical forms of the more widespread *D. latifolia*.

Further, according to Prain, the Andaman form of *D. Latifolia* by its inflorescence and the Malay Peninsula form of the same tree by its leaves seem both to approach the Java form, though as regards its pods the Malay Peninsula form is quite like the Northern Indian one and is quite unlike the Javanese

tree. In consequences of this similarity on the part of the Andamans tree, as shown by a manuscript drawing by Roxburgh, and of the Java tree, Prain has suggested the name *D. emarginata* to be adopted for the species. ([6])

R. S. Troup has mentioned that *D. sissoides* is a smaller tree than *D. latifolia* with more numerous leaflets, and lighter coloured and less compact foliage; the young leaves of *D. latifolia* are dark green, while those of *sissoides* are pale green. He also mentions that H. Tireman says, presumably of this species, that in Coorg the flowers appear in March and the fruits ripen in June. ([7])

In 1926, botanical specimens of two very similar Dalbergias—one of which flowered in February-March and the other in September, were collected and sent to Dehra Dun from Nilambur division (Madras), Mr. Parker, the then Forest Botanist, considered that the tree flowering in September was *D. latifolia* and that flowering in February-March was *D. sissoides*.

Wood specimens of the two trees were sent by the authorities in Dehra Dun to Dr. H. P. Brown, Professor of Wood Technology, Syracuse University, U.S.A. Mr. Brown stated that there is no reason to believe from the anatomical structure of the woods that we are dealing here with more than one kind of tree. He said that often times in wood of different species we find remarkable parallelism in structure, so much so that we cannot identify species by wood anatomy alone. He concluded by saying that we are possibly dealing in this case with two distinct species of *Dalbergia*, but if such is the case we must need arrive at this conclusion from other evidence aside from the anatomical structure of the wood.

It is thus evident that wood anatomy, by itself, will not prove any thing. It is possible, however, that the last word on this subject has not yet been spoken, although the available botanical opinion is more in favour of considering *D. latifolia* Roxb. and *D. sissoides* Grahm. as two distinct species.

LEAF-SHEDDING

The tree normally sheds its leaf at the commencement of the hot season.

In the deciduous forests at Dhoni (Madras) the tree has been described as being in full leaf even in March, the hottest month. ([11])

FLOWERING.

The tree generally flowers in July, but has also been found to flower in March (Brandis). There is some confusion as regards the correct flowering date of this tree as it is often confused with *D. latifolia* in the field. Troup has mentioned that as reported by Tiremen in Coorg *D. latifolia* flowers in September, the fruits ripening in March-April, while a variety of *D. latifolia* presumably *D. sissoides*, flowers in March, the fruits ripening in June. ([7])

Bourdillon says both *latifolia* and *sissoides* flower in January-February([1]). R. H. Beddome has stated that the tree flowers in the rainy season (July, instead of the hot weather (March-April) when *D. latifolia* flowers.([5])

FRUITING.

The fruit is an indehiscent 1-3, rarely 4 seeded pod, ripening probably from December to April according to locality. T. V. Venkateswara Iyer prescribed January to March as the proper time for the collection of ripe seeds of both *latifolia* and *sissoides* in Coimbatore South division, Madras.([12]) Prain notes that the fruit of *D. sissoides* is narrower and less rounded at the apex than that of *latifolia*.

SEED.

The seed has been described by D. Prain as much compressed, reniform, pale-brown, smooth but hardly shining, 0.35 in. long and 0.2 in. wide. The seeds weigh about 454 to the oz. and 7,264 to the lb. (Madras). The best time for collection of seed is December to March.([13]) Only ripe seed should be collected, and it must be noted that ripe and unripe seeds occur at the same time on the tree. ([12])

Storage :—Tests made in Madras have indicated that the seed rapidly deteriorates after six months storage, and that it keeps best when stored in gunny bags.

Dalbergia sissoides : Seed storage tests.([14])

Exptl. centre	Place of collection	Method of storage	Age of seed at the time of test	No. of tests made	*Germinative capacity.*		*Remarks.*
Madras	local seed	..	..	12	Initial	after 6 months	After 6 months rapidly deteriorates.
		Sealed tin.	6 months.	12			Keeps best in gunny bag.
		Gunny bag.	6 months.	12	75%	75%	

The table gives indications of the probable longevity of the seed and suitability of method of storage but more tests are probably necessary before reliable results are obtained.

Treatment :—Seed pre-treatment tests carried out in Madras indicate that hot water treatment is perhaps advantageous. The results, however, need further experimental confirmation.

Dalbergia sissoides :—seed pretreatment.

No. of tests made	*Average germinative capacity with*			
	Untreated	Cold water	Hot water	Boiling water.
30	26	26	32	5

For treatment with boiling water, water 20 times the volume of the seed used is brought to the boiling point, taken off the fire, the seed immediately put in and left to cool. For soaking in hot water, water as hot as the hand can bear is used.

For cold water the seed is kept in the water for 24 hours.

Germinative capacity and plant per cent. :

Experiments in Madras have shown that the germinative capacity is fairly high being 70 to 75 per cent for fresh seed and that the seeds are short lived, the percentage of germination lasting only for about six months after which it rapidly falls. ([15])

Dalbergia sissoides : germinative capacity.

No. of oz.	Seed per lb.	No. of weighments.	Plant per cent	Gram. cap.	No. of test.	No. of seeds tested.	Plants per lb. of seed.
454	7,264	90	51	70	70	40,000	3,705

SILVICULTURAL CHARACTERS.

There is little information under this head on *D. sissoides*, but the tree is so closely allied botanically to *D. latifolia* that it is likely to have been mistaken for it while conducting various field experiments in Madras, notably in Nilambur [16]. It may not be far wrong therefore to assume that, in localities with a west coast type of climate where *D. sissoides* has its principal home, the silvicultural characters attributed to *D. latifolia* are also applicable to *sissoides*. The tree is a moderate light-demander and benefits by overhead light. It is moderately drought resistant and is likely to thrive best on well drained deep moist soil, but may exist also on poor dry soils attaining here small dimensions. It coppices well and throws off root suckers with avidity.

ARTIFICIAL REGENERATION.

Like *D. latifolia*, the species is probably capable of being regenerated by all well known methods namely, direct sowing, transplanting entire seedlings and putting out root and shoot cuttings (stumps) but, as in the case of *D. latifolia*, stump-planting is probably the most suitable method of regenerating this species in localities with a west coast type of climate. Investigations carried out in Madras in which *D. sissoides* was introduced as stumps in 1938

gave a survival percentage in the first year of 97 per cent., and the same in the succeeding years was 97,96, 95,93,88 and 50.([17]) As regards the best date of stump planting investigations conducted at Dhoni, Begur, Kannoth and Topslip in Madras extending over a period of seven years have indicated the following ([18]) :—

(a) In districts having a west-cost type of climate the principal South Indian species, such as teak rosewood, *D. sissoides*, *Pterocarpus marsupium* and *Terminalia crenulata* can be stump planted before the monsoon breaks.

(b) Except in unusually hot and dry seasons, such as were not experienced during the seven years of these investigations, early stump-planting gives a sufficiently good stocking (often much better than early June planting) and a great gain in height growth as compared with normal early June monsoon planting.

(c) Success is not dependent on what is generally considered " good planting weather ".

(d) The great advantage given by the start the teak or other species get over the weeds or field crops more than outweighs any risk of poor stocking due to an exceptionally dry or hot season or other causes and this risk can be insured against by providing a reserve of plants for stumping in early June if the necessity should arise.

The best date of planting *D. sissoides* (and *D. latifolia*) are stated to be : for Begur—early May : for Dhoni—late April to early May : for Kannoth and Topslip —mid May, but these results are said to be provisional and requiring further experimental confirmation.

MANAGEMENT.

In forests worked under the Selection System the extraction of *D. sissoides*, like that of its twin species *D. latifolia*, from which it is not normally distinguished in the field, has been regulated in the existing working plan reports by prescribing a minimum exploitable girth or restricted to the harvesting of only dead, dying and overmature trees yielding marketable timber. The introduction of *sissoides* (or *D. latifolia*) in the annual teak regeneration areas of the Conversion working circle has also been prescribed for this species such introduction being, however, confined to rocky areas of limited extent that exhibit themselves on clearfelling. It is stated that the clearfelled areas should be regenerated in combination with field crops (*ponam* regeneration), by planting nursery raised stumps from two years old plants with an optimum diameter between 0.2 and 0.6 of an inch.([12])

RATE OF GROWTH

The rate of growth, as judged from the meagre statistics available, is slow at first. The following height growth has been recorded for the species introduced as stumps, in Madras ([17]) :—

Dalbergia sissoides : rate of growth.

		Mean height (inches)
1938	..	8.3
1939	..	12.1
1940	..	15.1
1941	..	16.8
1942	..	23.5
1943	..	29.5
1944	..	29.9

UTILIZATION.

Major Produce : Timber—The timber of *D. sissoides* is not generally distinguished from that of *D. latifolia* in the timber market and both species generally pass under the common name " Indian Rosewood ". Bourdillon states that in Travancore all carpenters and timbermen distinguish the two woods, and samples brought invariably show differences and could be separated; he mentions that the wood of *D. sissoides* is paler in colour. Such distinction is, however, difficult in the log and, so far as information is available, the logs of both species are being sold in Government and private timber depots of Madras, Mysore and Coorg under one common name "Rosewood". Both timbers sell at the same price. Bourdillon says the wood of *D. sissoides* has a purple ground colour like that of *D. latifolia* but is distinct from it in that it is much mixed with dark brown and has never any tint of red in it. He thinks some samples resemble walnut or one of the *Albizzias*, and the best way of identifying the species is to split a piece of the wood when the red or brown tint will at once be seen mixed with the purple.([1])

Weight 52 lbs.; P. 721 (Bourdillon). J.S. Gamble has recorded that among the wood

specimens received by him, the one from Mudumalai forest, Madras, labelled No. E. 3851) which was probably *D. sissoides* (and not *D. latifolia*) weighed 50 lbs. ([3])

Uses :—The timber is put to the same uses as that of *D. latifolia* Bourdillon says that between the two the wood of *latifolia* is generally preferred.

Minor Forest Produce.—The leaves are said to be eaten by cattle, sheep and goats, and the tree has been placed in the list of common fodder yielding trees in Madras Presidency. ([8])

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GEHRHARDT'S FORMULA FOR THE APPLICATION OF YIELD TABLE TO UNDERSTOCKED CROPS

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(The constant K of Gehrhardt's formula for the application of yield tables to understocked crops has been calculated for *Cedrus deodara* from the available data from sample plots thinned to E grade. The value of K shows high variation and is therefore not acceptable.)

The estimates of future yields of understocked crops are generally obtained by multiplying the normal yield table figures by the present stocking factors on the assumption that the growth per cent is unaffected by the density. If g and G are the growths of the understocked and normal crops respectively and d is the density of the understocked crop relative to the normal, then $g = dG$................(1)

But as the understocked crops tend to approach normality in course of time and the growth per cent varies with the density of stocking, this formula cannot give correct estimates of future yields although the estimates are on the conservative side. In order

Cedrus deodara.

Division	S.P. No.	Top age	Top ht.	Y.T. fractional quality	Crop age	SAMPLE PLOT FIGURES PER ACRE		Increment % p	Y. TABLE FIGURES FOR C GRADE*			Stocking on the basis of volume d	$K = \frac{p - P}{P(1-d)}$
						Standing timber volume C. ft.	Volume increment for next 10 yrs. C. ft.		Standing timber volume C. ft.	Vol. increment for next 10 yrs. C. ft.	Increment % P		
		Yrs.	Ft.		Yrs.								
Chakrata	75	62	92	0.4 I	61	4403	2086	47.4	6308	2180	34.6	.70	1.23
-Do-	77	57	78	1.9 II	57	4807	2020	42.0	5700	2090	36.7	.84	0.90
-Do-	78	61	79	1.5 II	60	4641	2200	47.4	4725	1950	41.3	.98	7.38
U. Bashahr	34	109	86	0.9 III	108	4281	769	18.0	6015	1190	19.8	.71	—0.31
-Do-	35	70	87	1.4 II	60	3749	2765	73.8	4570	1920	42.0	.82	4.21
Kulu	4	112	121	0.2 I	112	9903	1875	18.9	13120	1240	9.5	.75	3.96
-Do-	5	112	132	1.3 I	105	8694	894	10.3	14470	1330	9.2	.60	0.30
-Do-	6	63	99	0.9 I	63	5405	2026	37.5	7480	2270	30.3	.72	0.85
-Do-	9	99	102	0.8 II	94	5488	1681	30.6	8360	1510	18.1	.66	2.03
-Do-	14	68	117	1.7 I	67	6773	1911	28.2	9520	2390	25.1	.71	0.43
-Do-	15	66	108	1.2 I	66	6596	3141	47.6	8520	2290	26.9	.77	3.35
-Do-	34	54	102	1.8 I	53	6313	1961	31.1	6840	2600	38.0	.92	—2.27
-Do-	20	104	116	1.9 II	96	8433	1767	21.0	10710	1510	14.1	.79	2.33
-Do-	22	77	111	0.7 I	77	7679	1206	15.7	9572	1940	20.3	.80	—1.13
-Do-	24	95	112	1.8 II	90	6777	1734	25.6	9750	1630	16.7	.70	1.78
-Do-	25	94	112	1.9 II	93	7501	2464	32.8	10365	1580	15.2	.72	4.14
												Mean=	1.82
												S.D. =	2.39
												C.V. =	131%

* Ind. For Rec., Vol. XV, Part VIII.

to rectify this defect Gehrhardt modified the formula in 1930 as under :

$$g = dG\,(1+k-Kd)\ldots\ldots\ldots\ldots\ldots(2)$$

Where K is an empirical constant showing a definite relationship between the growth per cent and density of stocking and varies with tolerance of the species while other symbols have the same meaning as in formula (1).

K is determined from the relationship

$K = \dfrac{p-P}{P(1-d)}$, where p and P are the growth per cents for the next ten years in the understocked and normal crops respectively.

Our problem is to test whether Gehrhardt's formula is applicable to important Indian species. With this object four deodar plots (S.P. Nos. 52-55) were laid out in June 1940 in the Upper Bashahr division (E. Punjab) in understocked crops. These plots are due for full remeasurements in June 1950. Instead of waiting for the data from these four sample plots till then, an attempt has been made to utilise the data of deodar sample plots which have been thinned to E grade and remeasured at an interval of 10 years. The details of such data and computations of the values of K on the basis of volume are presented in a tabular statement on page 175 from which it will appear that on account of high variation in values of K it is not correct to use the mean value obtained.

As yield tables do not give basal area increment figures, it is not possible to calculate K on the basis of basal area and compare it with that obtained on the basis of volume.

NEW SAWMILL OF THE ANDAMANS FOREST DEPARTMENT.

By P. S. Khokhar,

Mill Superintendent, Forest Department, Andamans.

A sawmill consisting of circular saw benches existed on Chatham Island prior to the occupation of the Andaman Islands by the Japanese, who removed some of the important machines to the jungles for shelter and their own use. Whatever little was left of this original construction, was bombarded and heavily damaged by the British.

On re-occupation in 1945, it was decided to start the mill anew. The damaged mill had to be repaired, patched up and put together and stands functioning after hard labour. This sawmill, however, was too small to cope with the increasing outturn of timber from the forests and correspondingly high demand for sawn timber from the mainland. The Government of India's priority for post-war industrial development induced the Forest Department to plan out schemes for the building of a large-scale Band-Saw Mill. This was approved by the Government, the scheme being submitted by Mr. E.L.P. Foster, the then Chief Forest Officer, Andamans.

The construction of the main building of the mill was started in April, 1947, by the late Chief Constructional Engineer, Mr. F. E. Monin, and the ceremony for putting up the first post of the building was performed by Mrs. E.L.P. Foster on the 28th June, 1947. Unfortunately, however, Mr. Monin could not make much progress due to his illness and died in October, 1947, in the hospital at Dacca.

After Mr. Monin's sudden death, and in the absence of any suitable hand, the designing work of the mill was entrusted to me in October, 1947, and the construction of the building was continued by Mr. P. J. Connar, the Head Saw Filer and later on by Mr. A. Salvon, the Assistant Constructional Engineer who completed the skeleton work of the same in June, 1948.

As no drawings and designs were available, the first task was to complete these. The difficulties were enhanced in the re-arrangement and laying of machinery, as the building was improperly constructed. Completion of designing work was achieved in July, 1948, and the construction work was also entrusted to me.

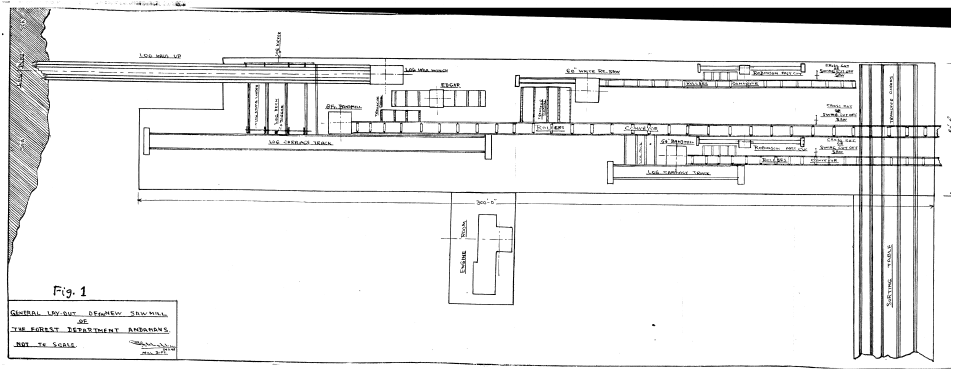

Fig. 1

GENERAL LAY-OUT OF the NEW SAW MILL OF THE FOREST DEPARTMENT ANDAMANS.

NOT TO SCALE.

MILL SUPT.

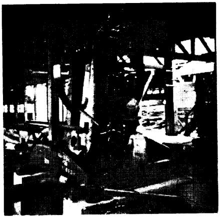

Fig. 2
8 ft. Band-sawmill, nearing completion of its erection

This mill has been designed for cutting 75 to 80 tons of green round logs of Andaman hardwoods per day of 8-hour shift. The total width of the building is 50 ft. and the length is 305 ft. It will be a steam driven mill. (Fig. 1)

The major parts of the mill and their functions are :—

Log Haul-Up.

This is, in fact, a heavily built wooden trough which runs from the sea to the top of the log deck, in which a very heavy endless chain travels upwards. The last is fitted with steel dogs. The butt of a log is caught by the dog spikes and the log is thrust upwards till it reaches the trough at the head of the sloped log deck. In this trough at the head of the log deck are situated ' log kickers ' which are steam operated. These kick the log from the trough on to the inclined log deck and it rolls down until brought to a stop.

Log Stop.

This machine is also steam operated and is situated at the bottom of the Log Deck. By the action of this machine, the log which is thrown out of the log haul trough by the kicker is stopped and loaded on to the log carriage as required.

Log Nigger.

This alone does the work of 15 to 20 labourers, as only one man can manipulate the large log on the log carriage through the main band sawmill. This machine actually fights with the log on the carriage. By the help of this machine, the log or the flitch on the carriage can be tossed about and its sides turned and slapped to rest against the log carriage head blocks. This rugged action fully justifies the name given to this machine.

Log Carriage.

This is a frame built of heavy timber mounted on ' V ' and flat faced wheels which run on heavy type of special ' V ' and Flat Rails fitted in parallel to the main band sawmill. On this carriage frame are three very heavily built cast steel head blocks, which take the log through the log stop and which are mechanically operated through friction drives. The carriage itself is driven forward and backwards at a speed of 100 ft. per minute feed and 200 ft. per minute gig, by means of a rope friction drive unit which is driven by a belt through the mill driving shaft. The operation and the feed of the carriage is controlled by the Sawyer, and the head block and feed of the timber to the saw as per cautions received from the Sawyer giving the thickness of the cut by the loggers who always remain on the carriage.

Main Head Rig or the Main Break-down Mill.

The main break-down saw is an 8′ Band Sawmill (Fig. 2) from Messrs. Clark Bros., U.S.A. manufactured in 1915. This is a very old machine but hardly used. This mill will break down the logs of 64″ diameter and squares up to 54″, and will run at about, 7400 ft. per minute and all of the wood is passed through the right hand side of the mill. The outturn of this mill will be carried away by the mechanically operated rolls conveyor. The flitches and squares required for further conversion will be passed on to the Edger, 60″ White Re-Saw or 54″ Fay & Eagan Saw by means of the cross transfer chains.

The heavy squares and flitches which are not required for further conversion will go to the further end, (outturn side) of the mill where these will be cut to sizes by a Swing Cross-Cut Saw, checked, marked and passed out through the mill on the dead roll section conveyor.

Edger.

This machine is just behind the 8′ Band Sawmill and it takes five circular saws of 24″ diameter. This is necessary for the most economical handling of the boards and scantlings coming from the main head rig. All the boards and beams coming out of this bench will be thrown on to the main live rolls conveyor, cut to lengths by the swing cross-cut saw, checked, marked and passed out of the mill by transfer chains to the sorting table, where these will be sorted out according to specifications and species and stacked in the timber sheds.

As good luck would have it, at the northern corner of the mill near the old sea wall was seen some massive junk of iron protruding out of the rubble. This, on further investigation, proved to be an old Edger supplied by Messrs. Clark Bros., U.S.A., sometime in 1922. This piece of machinery is of considerable use. When unearthed completely, it had parts missing. All these are being designed and made locally, so as to make it fit for use at the earliest. But the main parts were saved, perhaps by the hand that dropped

the bomb, in a way that the earth may enwrap it—" And God Almighty, there is some soul of goodness in things evil would man observingly distill it out."

60″ White Re-Saw.

This is actually a roller fed band sawmill. This bench is the backbone of the head rig. It is a very fast machine and the flitches coming from the head rig for further sawing into boards and beams, even the off-cuts of the logs which will be obtained on the first cut of the head rig, will be passed out of this machine. The outturn of this machine not requiring detailed cutting will be carried out by the live rolls conveyor to the swing cross-cut saw by which the boards, beams and scantlings will be cut to size, checked, marked and passed to the sorting table by transfer chains. The timber will be passed, sorted and loaded on to trolleys and sent to the timber sheds for stacking

54″ Fay & Eagan Mill.

This is also a band sawmill. It takes band saws of 7″ width. This mill will act as a pony mill and will actually back up the main head rig. When there is fear of any jamming up by the quick outturn of the head rig, the flitches will be passed on to this mill by the help of cross transfer chains. The flitches and squares on this mill will particularly be cut into railway sleepers. In other words, this section of the mill will be for sleeper cutting. This mill will also have a log carriage overhead log turner and nigger. The outturn of this mill will also be passed out of the mill in the same way as of other benches, by its own live rolls conveyor, after cutting to sizes by the swing cross-cut saw.

Detailed cutting benches.

There will be four benches for detailed cutting of timber. Two will be 36″ circular saw benches of fast-cut type and two will be band rip saws. The outturn of the Re-Saw and Fay & Eagan mill will be taken over by these benches for the detail cutting. The outturn of these benches will go straight on to the transfer chains to the sorting table. All the pieces will be sorted there, loaded on to the trolleys and sent to the timber sheds.

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The main breakdown mill will be fed with logs. This is backed by an Edger, a Re-Saw, Fay & Eagan Mill and four detail cutting benches. The flitches and squares which will be the outturn of the main break-down mill will be passed on to the Edger and Re-Saw for cutting into boards and beams. Other timber required to be sawn into sleepers will be passed to the Fay & Eagan mill. The off-cuts and remainder of all these will go to the four detail cutting benches. All the squares and flitches required for shipment will be passed right out of the mill by the live roll conveyors. The outturn of all other benches will go to the sorting table through the transfer chains after all the pieces are cut into sizes by the swing cross-cut saws. The sawn timber will be sorted out on the sorting table, loaded on to the trolleys and sent to the timber sheds for storing.

All the sawdust will be carried out to the main boiler fuel bin by sawdust chain conveyors. The major portion of the sawdust will be used for steaming up the mill boiler. The rest of the sawdust, according to recent proposal, will be supplied to the boiler of the new power generating station which is under construction. The off-cuts etc., will also be conveyed to the boiler by the trolleys and consumed with the saw-dust. Some portion of the off-cuts will be sold on concession rate to the employees of the Department.

There will be a long driving shaft running throughout the mill. The power from this line shaft will be transmitted to different benches by belts. The benches such as Edger and Fast-Cut Circular Saw benches which will be at right angles to this shaft, will be worked through right angle drives. The prime mover to run the mill will be 325 N.H.P. Marshall Steam Engine, which is at present running the existing circular sawmill.

All the benches are of old type, which were purchased in 1945-1946 from the Disposals by the Department, and arrived here incomplete. The missing parts, as well as the parts which have been worn away from the old machinery are being made locally.

Messrs. M. S. Balasubramanyam, the Chief Forest Officer and B. S. Chengapa, the Conservator of Forests, are taking keen interest in the early installation of this mill, and I am confident this will soon materialise.

When completed, this mill will be an emblem of Indian industry and the biggest, perhaps, so far erected in the EAST.

ACKNOWLEDGMENT.

The author is deeply grategful to Messrs. M. S. Balasubramanyam, Chief Forest Officer, and B. S. Chengapa, Conservator of Forests, Andamans, for reading through the original and final draft and giving their approval.

FOREST AND PHOTOGRAPHY.

By P.C. Mukherjee,

Artist-Photographer and Museum Curator, Forest Department, Bihar.

1. The usefulness of Photography in Forestry.

That photography is an aid to forestry is universally acknowledged. Specially in these days of democracy and publicity when forest officers have to make their forest and their work known to the laymen, photographs are helpful. It is an asset to forest officers to be able to take good snaps of different aspects of forestry and natural scenes. It is, however, desirable that the forest officer goes a little further and learns also to develop and print his films in camp. For example, he may be visiting a forest in remote corners which he is not likely to visit again, and where very few people go. He then takes photographs which are of very great importance, particularly because of their rarity. He cannot afford to take risks. Yet it might happen that by accident of bad loading or bad film or a leak etc., in his camera his pictures get vitiated. He will not know of it until he returns to town when the defect would have become irremediable. But, if he develops his films in camp, he can take other snaps to replace the faulty ones and will be sure of bringing with him the pictures he intended to bring.

There are manuals on photography and much literature. But this article has been written with the limited object of helping the forest officer to succeed with photography under the conditions in which he works.

2. GOOD PICTURES DO NOT NECESSARILY NEED GOOD CAMERAS.

Fast lenses and expensive gadgets may be useful to the professional and advanced worker but the novice will find himself better equipped to secure good results with an instrument that is easily set for actions and cost less, provided he bears in mind a few of the simple hints essential for the purpose and always keeps himself steady in his aim. In my opinion one should prefer to carry a tape to measure the distance than attempt to purchase a costly Range Finder. A darkroom equipped with all the modern developing and printing apparatus is needed by a developing and printing firm, who develop and print a large number of amateur exposures every day. But, a keen worker should not hesitate to try to develop his own films with some of the common household utensils for want of developing trays and a darkroom, when his work is of most limited nature. It will not only be a pleasure to him to be able to do his own job without entrusting the work to a firm, who often spoil his exposures, but it will be of immense help to him to know the art thoroughly and progress steadily to attain his goal.

The beginner should, therefore, note the following few hints before attempting to make an exposure with his camera:

1. Confine your attempts to snap a subject out of doors in direct sunlight. Do not make an exposure when there is no sunshine and when light and shade, which give life to the subject, disappear.

2. The best time for outdoor exposures are two hours after sunrise and two hours before sunset. During these hours the sun remains at the top and throws light on the subject to be photographed from one side at an inclination of about 45 degrees. Flat lighting is useless as it canot throw plenty of light and shadow on the subject, and the camera fails to record the details as the subject lacks in relief.

3. Always have the sun behind the camera when exposing and don't allow its rays to act directly on your camera lens, as this causes halation in the negative.

4. Avoid taking during winter any portrait with the blank sky as background. A strong light behind your subject will cause halation and spoil the negative.

5. There are two sides of photography—hunting the subject and recording it faithfully in the negative. You should always aim at the simplicty of the subject you take and compose the picture in your view finder, as best as you can, eliminating anything that appears to stand in the way of such composition.

6. Study the subject carefully to seize its essential unity and concentrate the interest on one point aiming to present to the beholder of the final picture, fully and truly, the feeling aroused by a beautiful manifestation of nature or a striking presentation of life and action. In other words the final picture you make should be so expressive as to tell a story to the observer. To do this, you should always try to secure the brightest lights, deepest shadows and tones between them in the subject. Avoid. therefore, hasty snaps if the light is not suitable.

7. Begin with landscape photography first. There is always a lusture and healthy outlook in landscapes. Trees in a landscape are stationary things and the main advantage of an expensive camera which is nothing but speed, is not needed. Remember always that it is the eye of the manipulator which is responsible for the quality of the picture made and not his camera. Only a bad workman quarrels with his tools.

8. If you spend a little time during holidays you can find materials for many pictures both in villages and towns worthy of recording with a camera. There is unending material close at hand for landscape photographers in the town of Ranchi as well as in the beautiful villages around it. Any clever eye can pick up material even from the most unpromising surroundings.

3. USEFUL GENERAL HINTS.

Casual snapshots often include large areas of entirely uninteresting objects and the beginner is strongly advised not to shoot a subject from his first view point but to compare two or more view points before arriving at a decision. In the previous section it has been stressed that to make a good pictures it is not the camera, which is only a tool, that really matters but it is the man working behind it. Any camera intelligently used will do good work for its operator. In this lies the photographer's art.

There should be only one main idea or theme in a picture and just enough secondary material to support and strengthen the theme. The beginner is cautioned against attempting to include any figure in the landscape situated at a closer range than the main theme as, in that case, the figure will occupy a larger area in the picture, (often also be out of focus) and spoil the negative. A figure, if introduced into a composition of this kind, should be placed much further off and shown on a smaller scale. It should be made to suggest a connection with the scene rather than that a friend of the photographer was hurriedly put in position. Discard anything that tends to make for conflicting interests in the subject. It should be remembered that a good sky rendering is almost a necessity for the success of any landscape picture.

Always carry a tripod with you, if you have one, and set the camera on it. If you have none, hold the camera perfectly steady by pressing it against the body while making the exposure. To avoid camera shake hold your breath also for the time being when releasing the shutter.

Many amateurs who start out with a new camera for the first time, naturally believe that pressing of the button or lever of the shutter must be quick in order that the exposure shall be fast enough. At the same time it is often assumed by them that a certain amount of force is needed to make the shutter open and close again. Both these assumptions are wrong. The exposing trigger is only for releasing a catch or spring which operates the shutter at the same speed, whatever the effect expended on pressing it. The result of too hard a push is often to jerk the whole camera which produces a blurred picture. In fact, the more gently the shutter is released, the more certain one is of securing a sharp picture.

One who has a waist level viewfinder should press the camera against the body but one who has an eye level finder in his camera should steady it by pressing it firmly against the nose, cheek bone or forehead.

4. A FEW DONT'S FOR THE BEGINNER

1. Do not load or unload the camera with roll films in direct sunshine. This should always be done indoors and in the shade. If you cannot get indoors, turn your back to the sun and open the camera in your own shadow.

2. Do not forget to wind the film on to the next number immediately after an exposure

and do not use exposure of a slower speed than 1/25th second when using the camera without a stand. It is extremely difficult to hold the camera still when using a slower speed than this, say 1/10th second. For longer exposures always use a stand to avoid camera shake.

3. During exposure do not allow your finger to project in front of the lens. This will partly block the view in the negative.

4. Do not carry your camera about in the sun uncovered, while searching for a subject to take. Light may penetrate into the camera and produce black patches on the film. Get a case for your camera. If you cannot get one, carry it hidden under the flap of your coat.

5. Do not expose part of the roll film on subjects in direct sunlight and part on subjects in the shade. It is extremely difficult to do full justice to both sets of exposures of such a roll during development. One of the sets will be either over or under developed.

6. Do not bring the camera too close to the subject you wish to photograph. Stand at least six feet away from it, to ensure sharp focus and to guard against distortion, *i.e.*, loss of perspective. This applies specially when taking a single portrait.

7. Do not touch the lens with your finger or thumb. A greasy finger-mark on the surface of the lens will give blurred result. Breathe on the lens and wipe the surface with a clean soft handkerchief if any such mark is detected.

8. Do not exert force to any part of the camera if its mechanism refuses to work. Carefully examine the defect and set it right.

9. Do not leave the roll loaded in the camera for a long time. This will affect the film. Get the roll developed soon after the last exposure.

10. Do not snap babies or pet animals from a high view-point. Snap them in the garden, unawares, from a low veiw-point to avoid distortion.

11. Do not allow the camera to get damp. Always keep it in cool dry place when not in use.

12. Do not leave a loaded camera uncared for on the drawing room table. Curiosity may lead some one to open it during your absence and thus spoil the roll. Moreover, there is every possibility of the camera getting into disorder if it is allowed to be handled by one ignorant of its mechanism.

5. HOW TO LOAD THE CAMERA WITH FILM.

Loading a roll film into the camera and unloading it after all the exposures have been made are very simple operations, whose method differs slightly according to the design of individual cameras.

A beginner, when he obtains his camera, should get the salesman to show him the way of loading and unloading a spool.

A novice can do the same himself without the least difficulty if he closely follows the following instructions:

1. Before loading the spool into the camera see that its front portion (if it is of a folding type) is closed. The film should never be loaded with the front portion of the camera opened out as in that case the back of the film is liable to be stained.

2. Lay the closed camera, face downwards, on the table. As now both hands are free, open the back lid and insert an empty spool at the winding end, taking care to see that its slotted end has got properly engaged with the winding key or knob. Turn the winding key and bring the longer groove of the spool on the top.

3. The new film should now be placed into position, into the other compartment opposite the winding end. See that the pivots are properly fitted into the holes in the two ends of the spool to avoid the backing paper of the film getting loose when the seal is broken thus allowing the light to penetrate into the film and spoil it.

4. If your camera is capable of making pictures of two sizes and if you decide to make the smaller size, put the mask in position first and when this is done, break the seal of the new spool, which is already in its chamber, and draw out enough paper to insert its point easily right through the slot of the empty spool. Care should be taken not to draw the paper underneath the film. The paper should be drawn over the film so that the spool rotates clockwise. Wind the key slowly till the slack paper is taken up and see that it remains between the flanges of the take-up spool.

5. Continue winding till the slack paper is laid flat and then close the back of the camera. Wind on again steadily till the number " 1 " appears in the red window. The film is now facing the lens and is ready to receive the exposure.

6. After the first exposure, wind on the key again until the number " 2 " appears and repeat the operation after each exposure till the spool is finished.

7. When the last exposure has been made, wind on the key again till the end of the long backing paper is seen to pass the red window and has been completely wound on the take-up spool. This is ascertained when tension is no longer felt in winding the key. You can now safely open the back of the camera and take out the finished spool. Of course, as has already been stated, loading and unloading the camera should be done indoors.

8. Most cameras require only a pull of the winding knob to release the exposed spool. Others have some device of their own, such as, a spring and a catch which keep the take up spool in position in its chamber, and it is extracted when this catch is pulled backwards.

After extracting the spool fold the end of the paper and reseal it with the gummed strip supplied with it.

Force should never be used nor it is necessary to do so either in loading the camera with a new spool or unloading it after the film has been used up.

6. PHOTOGRAPHIC DARK-ROOM AND ITS EQUIPMENT.

Photographic emulsions are sensitive to the action of ordinary light and are liable to be fogged if exposed to it for a short time. Hence, all operations requiring actual handling of the sensitive materials must be carried out in a room into which no day light can enter. The room is usually lit by a " dark-room lamp " for which either oil—or electric light is used. The light of the lamp is filtered through a red, orange or any other non-actinic medium, such as, glass or fabric. Dark ruby glass is used for developing all other emulsions except panchromatics (which are colour-sensitive), for which a special safe-light is used. Orange or yellow filter is safe for bromide and gaslight papers and lantern plates.

To make an ordinary room light-proof during day-time, one has to close all its doors and windows and hang heavy curtain and thick blinds against them. Besides, he has also to cover up carefully with felt seals any leakage in the window frame or crack in the shutter, through which light may penetrate into the room. Professionals and developing and printing firms have their specially constructed dark-rooms with the interior faces of walls and ceilings painted black with a dead matt colour, so that no light from the walls reflect upon the sensitive materials and affect them. They also provide means for the entrance of the fresh air (but no light) into the room usually through a tortuous path high up in the wall, as the air inside a closed room soon becomes foul.

But the beginner or a casual worker, who is not expected to do his developing and printing during day time, need not bother about a dark-room. At nigh the can conveniently utilise a bath room, in which water supply is available, for his photographic work. At that time the amount of light to be kept out is so very much smaller that quite a temporary method of darkening the room can be satisfactorily used. If any light from the adjoining room leaks through the cracks under the door shutter it will not matter much.

The following arrangements should be made in the room for photographic work:

Two tables should be kept in a corner of the room close to the walls. One of them (called the printing table) should be fitted with a drawer for storing opened packets of paper, etc. during printing. This table should be placed to the left hand side of the worker, while the other table should be in front of him. On the latter table (called the developing table) the dark-room lamp and developing and fixing trays should be arranged. For a permanent dark-room the top of the developing table is usually lined with zinc sheet to protect the surface of the wood from the chemical action of the developer and other solutions that splash on it during the work. The amateur can achieve the same object by covering his table with a few sheets of old newspaper and replacing them when they get spoilt. White light will be required for exposing paper and for this purpose an incandescent lamp or any other powerful oil lamp can be used in an adjoining room, if there is no electric supply (see printing). In case running water is not available in the room, water should be stored in vessels in sufficient quantity. Racks should be fitted for

storing dishes and also some shelves, within easy reach of the worker, for bottles. The bottle should be prominently labelled so that they can be read by the diffused light of the darkroom lamp without difficulty.

A thermometer with an open scale and reading up to 160° F, a measure (preferably of celluloid) of 4 oz. capacity and some chemicals complete the equipment necessary for a beginner's dark-room.

7. DEVELOPING ROLL-FILMS AND PLATES.

Developing is the production of the visible image on the exposed dry plate or film by the action of certain chemicals. No image is visible before developing on the dry emulsion after exposure in the camera. The process is conducted in a dark-room, and the following accessories and chemicals are needed for the purpose.

Dishes—Three dishes are required—one for the developer, one for plain water and the third for the fixer. Those who prefer to use photographic standard dishes—should select a quarter size set of three dishes as all sizes of films (upto $4\frac{1}{4}'' \times 3\frac{1}{4}''$) can be conveniently developed and printed with them.

Household equivalents of much the same size and shape, *e.g.* a small porcelain pie-dish or the outer body of a soap dish can be used equally well for the purpose. Enamelled bowls can also be satisfactorily used for developing roll films.

Developer—The developer may be bought ready-mixed either in powder or in solution form which requires only the addition of water to make up the working solution, and the beginner will find this more economical to use. Those who prefer to make their own developer should use the following formula, which is suitable for plates, films and papers.

Metol	4 grs.
Sodium Sulphite (Anhydrous) ..	88 "
Hydroquinone	15 "
Sodium Carbonate (Anhydrous) ..	60 "
Potassium Bromide	2-5 "
Water to make	5 Ozs.

Dissolve the ingredients in the order given, taking care to completely dissolve each chemical before adding the next.

Use.—For dish development of films and plates.—Dilute the developer with two parts of water.

For bromide and soft and normal gaslight-papers.	Dilute 1 to 1
For vigorious gaslight-papers	Use without dilution.

Fixer—Fixing salt can also be bought ready-mixed and the working solution is prepared by diluting it with water according to the maker's instructions which is printed on the label of the container. Those wishing to prepare their own should use the following acid fixing bath. In order to prevent frilling of the emulsion during hot weather, the developed film is first briefly rinsed in clear water and then hardened in the following Hardening Bath for about two minutes.

Chrome Alum	219 grs.
Water up to	16 ozs.

Above 85 degree F. add 2 ozs. of soda sulphate in the above hardening bath.

The hardened film is then transferred straight into the acid-fixing bath without any further rinsing.

Hypo	4 ozs.
Water	16 ozs.

When the hypo is perfectly dissolved and the bath becomes clear, add 2 ozs. of the following stock solution dissolving the chemicals in the order given—

Sodium Sulphite (Anhydrous) ..	2 ozs.
Glacial Acetic Acid	1 oz.
Alum (ordinary)	2 ozs.
Water to make	15 ozs.

The success in developing films and plates chiefly depends upon :—

(a) Freshly prepared developer, which must be accurately made and filtered before use. Stale developer looses its activity and fails to build the density in the negative.

(b) Freshly prepared acid fixing bath, which should also be filtered before use to free it from any grit. Stale

fixer will deposit a white scum on the surface of the film which is very difficult to remove.

(c) Maintaining the room temperature of the developer, water and fixer. For this reason the hypo solution should be prepared at the least an hour before the development in order to enable it to attain the temperature of the working room.

(d) Scrupulously clean dishes.

(e) Avoiding contamination of the developer with hypo and *vice versa*.

(f) Safe darkroom light.

Formula for high-temperature developer for plates and films:

Hot water about 125°F. ..	8 ozs.
Metol	$22\frac{1}{2}$ grs.
Sodium sulphite (anhydrous) ..	$1\frac{1}{2}$ ozs.
Hydroquinone	42 grs.
Sodium bisulphite (anhydrous) ..	15 grs.
Sodium carbonate (anhydrous) ..	$82\frac{1}{2}$ grs.
Potassium bromide	12 grs.
Cold water to make	20 ozs.

Dissolve the ingredients in the order given and use without further dilution.

Above 85°F. add 1 oz. of soda sulphate anhydrous or 2 ozs. of crystals in 20 ozs. of developer.

Time of development.

At temperature of

	65°F	70°F	75°F	80°F	85°F	90°F
Mins.	5	4	3	$2\frac{1}{2}$	2	2 nearly.

The above developer produces clean black negatives of decidedly finer grain. It is easy to make and cheaper in use. A part of a $2\frac{1}{4}'' \times 2\frac{1}{4}''$ negative has been enlarged by the author to 23×17 inches on dead matt paper without showing any appreciable grain.

Improving negatives.

On account of errors in exposures, developed negatives sometimes require modifications (before printing) to improve their printing qualities. They consist of:—

(a) Reduction of negatives.

(b) Intensification of negatives.

(c) Retouching of negatives.

Reducing the negative.

An over-exposed negative will be found after development to be veiled, too opaque and lacking in brilliancy. Such a negative can be improved by reducing the density in a reducer composed of hypo and ferricyanide. This reducer (commonly known after its inventor as Howard-Farmer's Reducer) is prepared as follows:

In 5 ozs. of water dissolve about $\frac{1}{2}$ oz. of hypo crystals and add to it a few drops of 10 p.c. solution of potassium ferricyanide. Pour the mixture, which should be of a light yellow colour and keeps for a few minutes, into a clean white dish and place the negative in it straight from the fixing bath. The dish should now be gently rocked till the required reduction in the density has very nearly taken place when the negative should be quickly removed and washed thoroughly for at least half an hour in running water. If the negative has been dried, it should be soaked in water, till thoroughly limp, before placing it in the reducer. Local reduction can also be done to any part of the negative which is found to be too dense (such as the sky portion) by holding it in the left hand and applying the reducer repeatedly to that part only requiring reduction with a soft camel hair brush. If the negative is a film it should be taken out of the fixing bath and placed flat on a piece of clean glass and the superfluous solution drained off by the corner. The reducer should then be applied to the dense part with the brush holding the glass with the negative in such a way that the solution may not run into the other portion of the image.

The negative should be rinsed now and then with water and the extra water drained off to prevent any hard line appearing in the negative between the portion that has been reduced and the rest. Local reduction can also be effected mechanically by rubbing the required part of the dry negative with a wad of cotton wool soaked in methylated spirit.

Intensification of the negative.

On the other hand if the negative has been under-exposed it will become very thin and devoid of sufficient printing contrast. Intensification is the means employed for remedying the defect and increasing its printing density. This is done by the application of mercuric

chloride solution and subsequent darkening. The negative that has to be intensified must be thoroughly fixed and washed. The mercuric chloride solution is then prepared as follows:

Mercuric chloride	.. .. ..	180 grs.
Hydrochloric acid	(concentrated)	35 Mms.
Potassium Bromide	.. .. ..	180 grs.
Water	.. .. ..	20 ozs.

Dissolve the mercuric chloride in hot water and cool it before adding the other ingredients into it. Store in a bottle, but *do not shake the bottle* while pouring the bleacher into the dish for intensifying the negative.

Bleach the negative in the above solution till its back becomes white and then darken it in a 10 p.c. sodium sulphite solution or any other non-staining developer containing Hydroquinone. Wash the negative in water for half an hour and then dry.

There are many other methods of instensification but the above is most generally used. It can be used repeatedly.

If mercuric chloride is not available or if the worker does not prefer to use it on account of its poisonous nature, the weak negative can be sulphide toned to improve its printing quality and a passable print can be obtained by this method even from a ghost-like negative.

(To be continued)

EXTRACTS

SYSTEM AND MANAGEMENT IN SWISS FORESTRY

By Bruce Urquhart.

(from "Wood")

I first visited the Swiss orests as a student in 1929, under the guidance of the late Mr. Bourne, when he was lecturer in forest management at Oxford. At that time we saw in the forests round Neuchatel the results of the intense application of Biolley's system known as the "Methode de Control," which has since been generally accepted in Switzerland and forms one of the basic concepts of management taught in the Swiss schools of forestry today.

I do not intend to enter into the details of its working, but broadly speaking it aims at the management of irregular uneven-aged forests of mixed species. Regeneration is mostly natural except where new species are being introduced, and felling is selective. (No clearfelling is permitted anywhere in Switzerland). A high production of volume and a high increment are aimed at, and by periodic remeasurement the amount to be cut is decided, usually every 6 years. The forest officer in charge is given wide powers and he marks such trees as he considers necessary to be cut. The concept of cutting or regeneration of certain areas and in fact the whole idea of area control is superseded by volume control. This is distinctly contrary to all the earlier methods founded on German forestry and of course to our normal practice in this country. There are many obvious objections to applying such a system to our forests, owing to a totally different environment. In my efforts to apply modifications of this practice to woods in this country, I had met certain difficulties which I was anxious to compare and discuss in Switzerland. One of the major problems in Britain has been the felling of selected trees in standing crops and their extraction without damage to the crop as a whole.

At Zurich, Dr. Liebundgut, the Professor of Forestry at the Techniche Hochschule, was kind enough to arrange some selective felling and extracting of timber in some of the nearby forests for me to see, and also to give me costs.

I have seldom seen axemen with so high a degree of skill as the Swiss, but apart from the methods of laying in, the use of the long wedges appeared the vital factor controlling the exact direction of the tree's fall. Once the butt has been sawn sufficiently one of the pair of men felling stands back and directs the other to hammer one or other of the wedges until the tree eventually falls. Each tree I saw, fell within a few inches of its intended direction and many contained 60 and 70 cu. ft. per tree. The stem is then trimmed and peeled of bark. The butt is rounded slightly to reduce friction and drag, and is pulled by horse to the roadside often in its full length. Sometimes the tops are cut off into pulp or firewood lengths and these are taken out separately on sledges or carts.

Normally most of the extraction is over snow, which is an obvious advantage. However, last year much of the extraction had to be over bare soil owing to lack of snow. On some of the higher elevations, in the selection forests I visited, such as at Swarzenegg, the forstmeisters told me felled trees would be barked and allowed to remain until the following winter's snow. In areas of dense young regeneration the trees are crosscut into shorter lengths in the forest, and some of the large seed trees are limbed before they are felled. In most cases the forest service undertakes the felling and extraction though the fellers are often men who are only temporarily employed. They are paid on piece rates and the forest service provides portable wooden cabins for them to live in. In the forest of Utligen near Zurich I saw families of men from Bergamo in Italy at work. Their families have worked for many generations and they come over for each felling season, returning in the summer to work on their farms. Their skill and speed of work exceeded anything I had seen elsewhere and the Swiss have for some time trained their own men on these methods. They use an axe weighing about 5 lbs. with a side curved blade rather like an executioner's axe, a bill hook, often in use to lift small billets with the point, and a hollow-backed crosscut saw of the American lance tooth pattern. They are paid to fell, trim and peel, and extract timber to roadside approximately 1*s*. 3*d*. per cu. ft. and earn up to £2 10*s*. 3*d* day, though they may work a 12 hour day for this.

The timber is sold by the roadside to merchants. Each leg is stamped with a number and the forester's measurements are accepted.

Bargaining is confined to defining the qualities of the logs which are governed by straightness as well as girth and taper. It is interesting to note that Scotspine commands a higher price than spruce. Larch is the highest priced coniferous timber but spruce and silver fir form the main species offered and are equally priced. The way in which wood is used for every conceivable purpose gladdens the eye of the timber merchant as much as the forester, and there is a tradition for this which adds much to the charm of the Swiss countryside.

Throughout my tour I discussed the economics of each operation and noted comparisons to our own methods with a view to applying them to the units under my own control. Inevitably the State forester is inclined to be out of touch with detailed costs and prices, but in Switzerland, the long established forest industry less disturbed by European wars, allows their officials the more stable conditions in which they can keep themselves abreast of the economic aspects of forestry.

Despite the legal powers of the forestry service, the fact that the bulk of the forests are owned by the cantons, who are jealous of their local authority and demand good financial returns, induces the forstmeisters to use tact and persuasion rather than invoke the letter of the law. The cantonal forests form 70 per cent of the total forests of of Switzerland and 25 per cent are owned by private individuals or corporations. The private owners are mostly farmers and units are usually small, often not more than 50 acres in one ownership. These owners are not allowed to clearfell their timber and the forest service inspects the marking of selection fellings before a sale is permitted. The whole system seems to work smoothly and with little friction. The forstmeisters hinted that their advice on silviculture was not always followed, indicating that private owners have a good deal of freedom in the way they manage their forests but recognise that in their own interests as well as the State's no devastation or serious neglect will be permitted. The finanical yields appeared to average from 30*s*. to £2 per acre per annum, though these figures do not take into account compound interest on the capital invested.

LESSONS FROM THE SWISS METHODS

Since the war I have been managing many small units of forest of under 300 acres each, on behalf of the Co-operative Forestry Society of Scotland, and my own woods amounting to about 200 acres. In every case the financial aspect has had to be paramount. In addition to the different environment in Scotland, with less frequent seed years and the enormous handicap of grazing vermin, we have a complicated system of taxation. In general the tradition for clearfelling and replanting makes it extremely difficult to embark on any selection system. For example the advantage of transferring an area to Schedule D depends on clearfelling. The application of planting grants to natural regeneration under a selection system for dedication is primarily designed for clearfelling.

However, I have attempted to adapt the Swiss methods to a number of compartments in forest units on several estates. Since I have to convert a stand from even-aged, to uneven-aged, there is a long preliminary stage before any of the detailed work such as for the "method of control," need be considered.

The cost of periodic remeasurement of the whole volume in order to ascertain the increment and therefore the periodic felling are considerable and to be avoided until the preliminary stages of conversion have been completed. In the majority of the areas under conversion the major task has been to control vermin and here it may be necessary to fence unless seed trees and regeneration are exceptionally abundant. Secondly, it has been necessary to open up any existing advance growth and give it more light and finally to remove inferior quality trees. The latter operation may be slow as it has always depended on markets, particularly firewood. The Swiss obtain 40 per cent of their forest revenue from sales of firewood and in certain forests even spruce brushwood is sold for bedding cattle. This preliminary stage may take as much as 10 years and any impatient attempts to hurry the process may lead to disaster.

VOLUME CONTROL

Once the stand is beginning to show signs of regeneration and the preliminary cleaning up has developed, the more detailed work of volume control can begin. Even then, for small units, an experienced forest manager who knows he must produce a certain sum annually or periodically to meet his expenses, should be able to mark his selection fellings without recourse to elaborate measurements, volume tables and graphs. There are certain occasions in the ownership of any forest when complete stocktaking is necessary, for example on death or change of ownership, and then the task should be carefully done and the

volumes recorded. The first working plan is perhaps another moment for 100 per cent enumeration.

The skill of the Swiss axemen can be and is often emulated by our own fellers but the tradition for clearfelling is so strong that I have often had to employ contract gangs of axemen and pay a special rate for careful felling. Close co-operation with timber merchants has also led to excellent results and the damage caused by felling and extracting among regeneration need not be serious, but can be appalling. The owner must recognise the extra work involved and the merchant understand and adapt himself to the methods and use the right gear for extraction.

Stands opened up by selection felling will remain remarkably free of wind damage provided drainage is good and studies made of wind velocities in Switzerland show that storms are not infrequent and severe. In fact unevenaged forests were often designed to replace unitform stands because they were less vulnerable to wind. I have been satisfied that our crops will also stand in very open spacing provided thinning has been adequate and the land well drained.

The close integration between forestry and agriculture is everywhere apparent in Switzerland. The majority of the labour is equally skilled on the farm or in the forest. How often can this be said of workers on the average private estate in Britain ? The old estate craftsman can still turn his hand to anything and this type of man is still essential to the average small acreage of woods on an estate. Both farming and forestry are full of seasonal peaks of activity and experience has shown me that provided an organisation such as a co-operative forestry society or a firm of forestry consultants can provide highly skilled foresters or part time management to draw up the season's programme and mark thinnings and selective countings a farm staff can easily be taught to undertake all the forestry work. Of course where large areas of work exist, such as replanting areas felled during two wars, or an extensive thinning programme is necessary, contract labour may be essential.

To sum up, the main lesson to be learnt from the Swiss seems to be devotion to an ecological approach. That is, that we must vary our species to suit the microclimate, and detailed environmental conditions of each compartment or sub-compartment. Our choices are complicated by all the recently introduced exotics and where these are to be used it seems wise to incorporate at least some of the naturally dominant native species. The increasing use of beech among coniferous stands in Switzerland should warn us not to neglect this hardy, wind-firm soil improver. We must also consider the necessity of retaining more shade-bearing species in all our plantations. Silver fir has for long been a feature of our woods and produced trees of enormous volume in exposed and unfriendly sites, and owing to its tolerance of shade stood up to neglected thinning. What is to take its place ? Selection felling with natural regeneration, sometimes accelerated by planting, can be adapted to our maturer stands provided we patiently follow the right methods. In Switzerland this method has proved itself financially but Swiss silviculture is not dogmatic and allows for any method except clear-felling. Only very favourably stocked and sited stands are suited to these methods, in Britain.

For the small scattered woods of this country agricultural workers can be adapted to the seasonal requirements of forestry provided there is skilled direction.

THE PRIVATE ESTATE

The private estate owner with the problems of land management as a whole before him, is ideally situated to hold the balance between the varying demands of forestry and agriculture. He can apply the basic principles of sound forestry provided he is helped by experienced advice on the more skilled operations. To make use of the more difficult and sporadic markets for minor forest produce, dogmatic silviculture and working plans must often be modified, for as in Switzerland the profitableness of forestry depends on the sale of minor products such as firewood.

The Forestry Commission's efforts to promote private forestry have been sincere, at least in the post war years, but the dedication scheme still appears to be a somewhat complicated way of doing this . Owners are concerned that if they are committed to a long term plan to stock their woods fully at the present day costs of replanting, there should be no recurrence of the market conditions prevalent from 1920 to 1939 when early thinnings were unsaleable. Provided there is some guarantee that prices of home grown timber will always be correlated to planting costs, the implica-

tions of dedication are no more severe than the laws prevalent for many years in all other European countries. For the owner who really manages his woods well there is some encouragement to know that under dedication the woods must continue to be well cared for.

BIG BEAR . . . . . . MIGHTY BIG !

(FROM 'FOREST AND OUTDOORS')

The big three-quarter ton bear was only three or four jumps from the men and horses, when George Bugbee stopped him with a single shot.

BY F. FLEMING.

The World's biggest grizzly, if it is a grizzly, and the third biggest bear of any kind ever recorded anywhere in the world was shot within 60 miles of Rocky Mountain House, Alberta, recently by George Bugbee, guide and outfitter for big hunters, in defence of his party of hunters.

George had his party of hunters out in the mountains for game, and while going down a narrow box canyon along Limestone Creek in the Clearwater Gap, they broke through thick scrub timber into a small clearing to find they had disturbed a huge bear while he was feeding on a freshly-killed moose. The bear reared to his hind feet, standing a good 100 feet high or more, and sighting the disturbing element he immediately charged them with a roar that should have terrified them if his huge size had not already done so. At first sight and scent of the bear, the horses had panicked, and in a matter of seconds or less, the scene was a confusion of milling rearing, plunging horses and desperate men. Bugbee jumped from his horse and let it go, though precious seconds were lost while freeing himself from a lead horse's rope, which had encircled him.

Kneeling and taking quick aim with his Winchester .30/06, he fired at the charging beast. It dropped at the first shot, and another one was not necessary. One bullet had done the job. Entering the open mouth of the enraged animal, it broke a front tooth in its passage, and lodged in the brain at the back of the skull. It was the only possible spot, from the position of the men and the bear, which could have stopped him before reaching the party of men and horses.

After the horses were brought under control and the men gathered around Bugbee and his bear, they could not believe what they were looking at. Just 75 feet from where the shot was fired, the huge bear lay dead. Measuring 9 feet from head to rump, he weighed between 1500 and 1600 pounds. His head measured 19" from front to back, his front foot was 9½" across, and the hind foot was 12" long, not counting the 4" claws. The beast's tusks were 2" long and the condition of them would indicate many years of life and many fierce battles, for they were worn and broken in many places.

Hunters who claim to have measured bear tracks where they have been running, claim they have measured 17-foot jumps for bears smaller than this one, and do not doubt he could cover 20 feet at a jump without any difficulty. In that event he was just over three good jumps from the men and horses when George's steady aim and cool nerve stopped him.

Difficulty has been experienced in identifying the bear, for while it is a well-known fact that grizzlies vary in their colour and markings, this big fellow does not seem to have any of the things a grizzly should have. He is not silver tipped, but shows a tawny shading on the shoulders and along the backbone, which is more indicative of the colouring of an Alaska brown bear. While this is far south of the usual range of the big Alaska bears, it would not be impossible for them to drift down the ranges this far. If it is an Alaskan, it is the first time one has ever been spotted this far south. This bear has black claws instead of the white ones a grizzly should have. His great size would indicate he was an aged bear, of whatever species, but he has no mane, which a grizzly should have.

As we go to press, Mr. Bugbee was still trying to get authentic identification of his bear, for

it is a valuable trophy. If it is a grizzly, it is by far the largest ever recorded and the third largest bear of any kind ever recorded anywhere in the world. The largest bear on record is an Alaskan brown bear that had a skull measurement of $19\frac{3}{16}$". The skull on George Bugbee's bear has an official measurement of 19 inches.

> Writer Fleming sent us a flash just before press time : "Nothing here has ever created so much interest. Any number of American newspapers, magazines and writers as well as naturalists and big game hunters have been flooding our little P. O. with letters."

ON THE CAUSES OF CONGESTION IN DENDROCALAMUS STRICTUS (Nees)

By

DR. K. KADAMBI, ASSTT. CENTRAL SILVICULTURIST AND A.S. RAWAT, HEAD COMPUTOR *

INTRODUCTION

A congested bamboo clump is one in which the bamboos not only grow too densely but are also more or less deformed. The Male Bamboo, *Dendrocalamus strictus*, being one of the cheapest and most convenient of materials for multifarious uses, is of great importance in the every day life of a large section of the people of our country. In addition, the increasing demand for bamboos especially for the paper industry, and its decreasing supply close to our large centres of population, make it imperative to find possible methods of improving its growth both in quality and quantity. Congestion in bamboo is one of the causes of low production and quality. In a congested clump there is little space for the growth of new culms and those that emerge from the rhizome have to wriggle through a mass of others, often mostly deformed, and in this process many culms get crooked, interlaced and deformed thus becoming unmarketable. Besides this, the extraction of bamboos from a congested clump is not only difficult but sometimes even impossible; indeed, the majority of culms of a badly congested clump have to be cut into several bits before they could be extricated from the clump.

Many causes have been attributed to the production of congestion; any factor, for example, which checks the development of the rhizome at the periphery of the clump or promotes the production of strong side branches or causes interlacing and bending of the culms or introduces growth within the body of a clump is known to cause congestion.

Maltreatment of clumps by human agency is probably one of the main causes of congestion in bamboo which is often noticed at the outskirts of forest villages. In several localities, notably those where heavy and irregular cuttings have been practiced for a long time, the majority of the clumps may be found congested. Growth of new culms normally tends to be peripheral, but as the usual tendency of the cutter is to remove culms from the periphery of the rhizome this being most convenient to him, unfavourable growth conditions are created resulting in the growth of the rhizomes being pushed towards the clump centre; congestion is thus probably increased. The villagers living within or adjoining forests injure the bamboo clumps in various ways and are therefore perhaps primarily responsible for causing congestion.

Cattle, monkeys and elephants also damage the clumps and thereby cause congestion. The tender shoots emerging from the periphery of a clump are destroyed by grazing and such culms often send out a number of lateral shoots which interlace with the other normal ones and start congestion.

The other probable causes of congestion are insect damage and want of exploitation or underfelling. Culms often bend and interlace owing to insects attacking and damaging portions of their body; among such insects are *Cyrtotrachelus longipes* and *Estigmina chinensis*. In inaccessible areas where periodical fellings cannot be made culms often get congested and therefore degenerate in quality.

With a view to determine the causes of congestion and devise preventive measures an experiment was started in 1934 in the research garden, Forest Research Institute, Dehra Dun. Comparable sets of bamboo clumps were subjected to six kinds of felling treatments resembling more or less those suffered by the bamboo in natural forest. Observations were made and data collected over a period of 12 years. The conclusions drawn are based on these data.

Moreover, in order to find if congestion is a hereditary character and whether the method of raising the bamboo has any influence on congestion, clumps raised by three different methods from stock of known character with regard to congestion were used for the experiment.

The experiments were laid down in Compartment 11, a bamboo plantation containing 18 rows of clumps raised by three methods thus. The first six rows of clumps on the northern side were raised from natural forest seedlings found under *congested* clumps which had flowered 3 to 4 years before the date of planting in the research plot (6-6-1927); the second six rows were raised by direct sowing in the research plot of natural forest

*The statistical information herein contained was extracted from a paper submitted by Shri A.S. Rawat for the "HOWARD MEDAL" 1948.

Fig. 1

Dendrocalamus strictus : Cutting one half the total number of mature culms around the periphery, (Treatment A).

Experimental Garden, F.R.I., Dehra Dun.

(Photo taken on 10. 8. 37.)

Fig. 2

Dendrocalamus strictus : Cutting one half the total number of mature culms, leaving the balance uniformly scattered over the clump, (Treatment D).

Experimental Garden, F. R.I., Dehra Dun.

(Photo taken on 7. 7. 38.)

seed obtained from a *100% congested* bamboo area on 5-6-1927, while the last six rows were raised by planting in the research nursery of rhizomes taken from 12 to 13 years old *uncongested* clumps, also from natural forest, on 15-6-1927. The Plot Chart (Enclosure No. 1) shows the lay out of the experiment.

Preliminary work carried out at first formation:—Clumps which contained more than 8 culms were enumerated and a very light cleaning, consisting of the removal of dead and dying culms having no green branches, was carried out. 192 clumps in the plot were classified according to their condition as follows.—

(1) **Congested** class, consisting of clumps which were congested or in which the culms were growing so dense as to have distinct signs of congestion,

(2) **Uncongested** class, consisting of clumps without any signs of congestion.

The culms in each of the 192 clumps were enumerated and their sizes at the third internode recorded under 5 diameter classes as below:—

Classes	IA	I	II	III	Switches
Diameters (in.)	2.55 and over	from 1.7 to 2.55	from 1.2 to 1.7	from 0.6 to 1.2	Below 0.6

Treatments applied at the initiation of the experiments July 1934.—The following treatments were applied:—

Treatment A—Cutting at the periphery of each treated clump, one-half the total number of *mature* culms found in the clump (Fig. 1)

Treatment B—Cutting, at the *periphery* of each treated clump, one-half the total number of *new* and *mature* culms found in the clump.

Treatment C —Cutting, at the *periphery* of each treated clump, one-half the total number of *mature* culms, leaving stumps 4 1/2 to 5 1/2 ft. high.

Treatment D—Cutting one-half the total number of *mature* culms under a thinning principle, *i.e.*, leaving the remaining culms uniformly distributed over the clump (Fig. 2).

Treatment E—*Topping i.e.*, breaking the tops of the new culms in one-half the number of clumps given this treatment and splitting the new culms in the remaining half.

Treatment F—Control; clumps not subjected to any of the above felling treatments (Fig. 3).

The 192 clumps were evenly distributed and allotted at random to each treatment, thus giving 32 treated clumps under each of the treatments.

Treatment E was continued only up to June 1940 and its results were then summarised by Sri Jagadamba Prasad, Experimental Asstt. Silviculturist, in more or less the following words:—

(i) Congestion is increased more by injuring new* culms, causing very strong, long and interlacing branches in poor quality bamboos.

(ii) Injury to new culms results in degeneration of the quality of bamboos.

(iii) Production of new culms has taken place more from the inner rhizomes than those at the periphery, and these, for want of space, become interlaced (in 68% of the clumps).

(iv) Production of switches is greatly induced by this treatment.

(v) Premature death of culms (in 75% of the clumps) and subsequently of clumps is most probably caused by repeated injuries to new culms.

(vi) Insect attack was found more in new culms than in the old ones.

(*) New culms mean those belonging to the last growing season and under one year old.

Initial comparability of the clumps.— The distribution of the treated clumps, raised by the three different methods described above, under the different treatments is given in table la below:

Table la—Distribution of the clumps under various treatments.

Method of raising	Wildlings transplanted (X)		Seeds sown (Y)		Rhizomes planted (Z)	
Treatment	Uncongested	Congested	Uncongested	Congested	Uncongested	Congested
1	(number of Clumps of each kind)					
A	4	7	9	0	6	6
B	4	7	9	0	6	6
C	4	7	9	0	6	6
D	4	7	9	0	6	6
F	4	7	9	0	6	6
Total:	20	35	45	0	30	30

The number of clumps of the congested and uncongested class were distributed under various treatments as below:

Table lb.—Distribution of the congested and uncongested clumps under each treatment.

Treatment	A	B	C	D	F
	(number of clumps)				
Uncongested	19	19	19	19	19
Congested	13	13	13	13	13
Total:	32	32	32	32	32

The clumps were apparently comparable though they had been raised by three different methods. The initial percentages of uncongested and congested clumps were thus 59 and 41 respectively under each treatment.

The distribution of the uncongested and congested clumps under each method of raising is shown in the table below:

Table lc—Number of uncongested and congested clumps raised by different methods.

Method of raising	(X)	(Y)	(Z)	Total
Clump condition				
Uncongested	20	45	30	95
Congested	35	0	30	65
Total:	55	45	60	160

Analysing the data of the above table, by applying chi-sq. test through Snedecor and Brandt's formula, we have the following :—

$$\text{chi-sq.}\frac{160^2}{95\times 65}\left\{\frac{20^2}{55}+\frac{45^2}{45}+\frac{30^2}{60}-\frac{95^2}{160}\right\}$$

$=45.05$

The tabular value of chi-sq. for probability (p) =.01 and degrees of freedom (d.f.) =2, is 9.21. We therefore see that the departure from expectation is significant which shows that in 1934 the condition of the clumps raised by different methods differed significantly from one another with respect to congestion.

In July 1934, when the initial treatment was given, a minimum of 6 culms was left behind in each clump. New culms produced after the treatment, in the growing season which followed, were enumerated and their sizes also recorded in December 1934. Statistical analysis shows that there is no significant difference among these new culms, both in diameter and number, produced under the various treatments; but the difference of the culms produced in the clumps raised by the three different methods was highly significant only as regards number. There was also highly significant difference, both as regards clump diameter and number, among the replications.

The following tables illustrate the above remarks :—

Table 2—Analysis of variance in the number of new culms.

Variation due to	Degrees of freedom	Sum of squares	Variance	Variance ratio			
				Observed	Expected at		
					5% level	1% level	0·1% level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Replications ..	31	1157.3	37.33	10 06	..	..	1 60
Methods of raising (R)	2	163.1	81.55	21.98	..	..	7 35
Treatments (T)	4	0.9	0 23	0 06	2.45	..	..
Interaction : (R x T)	8	1.0	0.13	0.04	2.02	..	..
Residual error	114	223.3	3.71	..	..	..	..
Total ..	159	1745.6	..	..	..	..	..

Table 3—Analysis of variance in the diameter of new culms 1934.

Variation due to	Degrees of freedom	Sum of squares	Variance	Variance ratio			
				Observed	Expected at		
					5% level	1% level	0.1% level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Replications	31	15.9	0.51	1.96	..	..	1.60
Methods of raising (R)	2	04	0.20	0.77	3.08	..	..
Treatments (T) ..	4	0.6	0.15	0.58	2.45	..	..
Interaction : (R × T)	8	1.0	0.13	0.50	2.02	..	..
Residual error	114	29.6	0.26	..	..	..	..
Total ..	159	47.5	..	..	..	..	..

The sets of clumps subjected to the treatments A to F (except E) were also comparable to one another with regard to the number and diameter of the culms produced during 1934, but the three sets of clumps raised by the three different methods (X), (Y) and (Z), compared to one another, showed significant differences both as regards number and diameter of the new culms of 1934.

The following tables illustrate the above:—

Table 4:—Statistical comparison of the number and diameter of the new culms of 1934 classified under different treatments.

Treatment:—	A	B	C	D	F
Mean number of new culms 1934 ±S.E.	2·9± 0·340	2·8± 0·340	3·0± 0·340	2·8± 0·340	2·9± 0·340
Mean diameter of new culms ±S.E.	0·73± 0·090	0·80± 0·090	0·72± 0·090	0·88± 0·090	0·83± 0·090

Details of further treatments— The treatments of 1934 (A to F) were repeated, more or less under a 3-year cycle, in February-March 1937, 1940, 1943 and 1946. During each of these treatments the culms of each clump were enumerated and their diameters recorded as was done in 1934. The condition of the clumps, whether congested or otherwise, was also noted.

Effect of the treatments on clump condition—Enclosure No. 2 show the number of clumps of each condition (congested or otherwise) under the treatments A to F (except E) for the years in which the treatments were repeated. Some clumps had died by 1946. The treatments also altered the condition of the clumps, there being a decrease in number of the congested clumps under all the treatments except F (control).

The following table shows the numerical changes between uncongested and congested clumps at the beginning and end of the experiment:—

Table 5—Statistical comparison of the number and diameter of new culms of 1934 classified under the different methods of raising the clumps.

Origin	Wildlings trans planted (X)	Seeds sown (Y)	Rhizomes planted (Z)
Mean number of new culms±S.E. ..	4·3+0 .260	2·4+0·287	2·1+0·249
Mean diameter of a new culm±S.E. ..	0·84+0 069	0·71+0 :076	0·81+0·066

Table 6—Comparison of the condition of clumps, 1934 and 1946.

Treatment	A		B		C		D		F		Total	
Condition	1934	1946	1934	1946	1934	1946	1934	1946	1934	1946	1934	1946
Uncongested ..	19	30	19	27	19	25	19	29	19	15	95	126
Congested ..	13	2	13	1	13	6	13	2	13	16	65	27
Total ..	32	32	32	28	32	31	32	31	32	31	160	153
Number dead	nil		4		1		1		1		7	

On analysing the above data by chi-sq. test with Snedecor and Brandt's formula we have—

$$\text{chi-sq.}=\frac{(153)^2}{126\times27}\left\{\frac{(30)^2}{32}+\frac{(27)^2}{28}+\frac{(25)^2}{31}+\frac{(29)^2}{31}+\frac{(15)^2}{31}-\frac{(126)^2}{153}\right\}=34.02.$$

The tabular value of chi-sq. for probability=.01 and degrees of freedom=4, is 13.28. The condtion of the clump as regards congestion has changed significantly as a result of the treatments. The frequency per cent of uncongested clumps under each treatment in 1934 and 1946 has been compared in Table 7—

From the table it is seen that congestion has greatly decreased under the treatments A to D, while under F which includes the unworked set of clumps (control) it has increased from 41% to 52%...

Effect of heredity on congestion—If the condition of the clumps be examined under the three heads (X), (Y) and (Z), we get the figures in the subjoined table

Table 7—Frequency per cent of uncongested and congested clumps under each treatment in 1934 and 1946 compared.

Treatment	A		B		C		D		F	
Condition ..	1934	1946	1934	1946	1934	1946	1934	1946	1934	1946
Uncongested ..	59	94	59	96	59	81	59	94	59	48
Congested ..	41	6	41	4	41	19	41	6	41	52

Table 8—Number of uncongested and congested clumps found under each method of raising in 1946.

Method of raising	(X)	(Y)	(Z)	Total
Condition of clumps				
Uncongested	43	35	48	126
Congested	12	5	10	27
Total ..	55	40	58	153

Applying chi-sq. test to these data, we get

$$\text{chi-sq.}=\frac{153^2}{126\times27}\left\{\frac{43}{55}+\frac{(35)^2}{40}+\frac{(48)^2}{58}-\frac{(126)^2}{153}\right\}=1.39$$

The tabular value of chi-sq. for probability=.05 and degrees of freedom 2 is 5.99. It is therefore clear that the clump condition (congestion) among the three sets of clumps (X), (Y), (Z), which are hereditarily different and have also been raised by three separate methods, did not differ significantly in 1946 although they did differ in 1934.

The following table shows how the percentages of congested clumps stood in the three different sets in 1934 and 1946:—

Table 9—Percentage of congested and uncongested clumps in the three sets of clumps (X), (Y), (Z), in 1934 and 1946.

Methods of raising	Forest transplants (X)		Seeds sown (Y)		Rhizomes planted (Z)	
Condition	1934	1946	1934	1946	1934	1946
Uncongested	36	78	100	88	50	83
Congested	64	22	0	12	50	17

It is seen that in (X) and (Z) the percentage of congestion has appreciably decreased but in (Y) it has risen from 0 to 12 per cent. This set of clumps, as already stated, was raised from seed obtained from a 100 per cent congested area of Lansdowne division.

Effects of methods of raising, treatments and time on the diameter and number of new culms—The mean number of new culms produced by each clump in the years of treatment 1934, 1937, 1940, 1943 and 1946 under the different treatments and methods of raising are detailed in Enclosure No. 3. If we analyse the numbers of new culms and their diameters (Enclosure No. 4) by analysis of variance, we find a highly significant difference between treatments, methods of raising, years and between interactions of methods of raising and treatments. Tables 10 and 11 below show details of analysis of variance.

Table 10—Analysis of variance in the number of new culms produced from 1934 to 1946.

Variation due to	Degrees of freedom	Sum of Squares	Variance	Variance ratio			
				Observed	Expected at		
					5% level	1% level	0.1% level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Methods of raising (R)	2	798.3	399.15	38.45	2.99	4.60	6.91
Treatments (T) ..	4	568.7	142.18	13.70	2.37	3.32	4.62
Years (Y) ..	4	2849.2	712.30	68.62	2.37	3.32	4.62
Interaction (R×T) ..	8	242.3	30.29	2.92	1.84	2.51	3.27
(R×Y) ..	8	147.2	18.40	1.77	1.84	2.51	3.27
(T×Y) ..	16	251.6	15.73	1.52	1.64	1.99	2.54
Residual error ..	757	7858.9	10.38	..	..	..	..
Total ..	799	12716.2	..	..	..	..	..

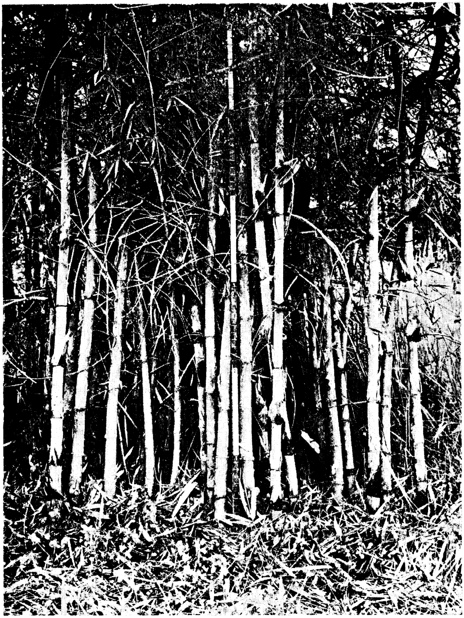

Fig. 3

One of the *Dendrocalamus strictus* clumps left unthinned as control (Treatment F.). Experimental Garden, F. R. I., Dehra Dun.

(Photo taken on 7. 7. 38)

Table 12 below shows the analysed statistics of the mean number of culms produced per clump and mean diameter of the new culms for the years of treatment. We find in 1937 a significant rise both of the number of new culms produced and their diameter. But, after 1937 the number of new culms falls progressively till the last treatment year 1946; the diameter, however, attains its maximum first in 1940, after which it also declines progressively. It has to be observed, however, that the 1934 figures are significantly less than those of 1946 both as regards number and diameter. The increase both in the number and diameter of the new culms between 1934 and 1937 is very striking, so striking in fact, as to make one doubt the very varacity of the figures. There could only be one reason for this great variation and that is, that the majority of the clumps were immature at the time of the first treatment in 1934, the (X)set of clumps being at the most 10 years old, and the (Y) set being only 7 years old and therefore still quite immature.

Table 11—Analysis of variance in the diameters of new culms produced from 1934 to 1946.

Variation due to	Degrees of freedom	Sum of squares	Variance	Variance ratio			
				Observed	Expected at		
					5% level	1% level	0.1% level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Methods of raising (R)	2	7.35	3.675	17.42	2.99	4.60	6.91
Treatments (T) ..	4	8.42	2.104	9.98	2.37	3.32	4.62
Years (Y) ..	4	54.79	13.698	64.92	2.37	2.32	4.62
Interaction (R×T) ..	8	5.24	0.665	3.10	1.84	2.51	3.27
(R × Y) ..	8	2.04	0.255	1.21	1.84	2.51	3.27
(T × Y) ..	16	6.07	0.379	1 80	1.64	1.99	2.54
Residual error ..	757	160.02	0.211	..	..	..	..
Total ..	799	243.93	..	..	..	..	..

Table 12—Mean number of new culms produced per clump and their mean diameter for the years of treatment.

Year	1934	1937	1940	1943	1946
Mean number of new culms per clump±S.E.	2.9±0.255	8.4±0.255	6.1±0.255	5.5±0.255	3.9±0.255
Mean diameter of a new culm per clump±S.E.	0.79±0.0363	1.48±0.0363	1.51±0.0363	1.36±0.0363	1.27±0.0363

The statistically analysed figures of the mean number of new culms produced per clump and their mean diameter for each treatment are given in table 13 below. The table shows that treatments A and B are significantly inferior to C, D and F both as regards number and diameter of the new culms, but, there is no significant difference between A and B and also among C, D and F with respect to the above.

An examination of the number and diameter of the new culms obtained shows that clumps from transplants (X) are significantly superior to both clumps raised from sowings (Y) and those from rhizomes (Z), as shown below :—

It is seen that (Z)-clumps are significantly better than (Y)-clumps as regards number of new culms produced. For culm/diameter (Z)-clumps are the best and (Y) clumps the worst.

Comparison of the yield of culms under different treatments :— The yield (the number of culms removed for the purpose of the treatments) in 1937 did not differ significantly among the different treatments. But, by 1946 *i.e.* after five treatments, treatment D proved to be the most advantageous, and its yield was found significantly better than that of B. Besides this, under treatment D there was no appreciable difference between the number of culms removed at each cutting of the years 1937, 1940 etc. (Table 15). A glance at the table also shows that for treatment B the yield in 1946 is much less than that in 1937, being less than one half. For treatments A and C the trend of the decreasing yield is almost similar to that of B. Treatment D therefore seems to be the most advantageous from the yield point of view.

Table 13 : Mean number of new culms produced and their mean diameter for the different treatments.

Treatment	A	B	C	D	F (Control)
Mean number of new culms per clump±S.E.	4.8±0 .255	4 .0±0 .255	5 .7±0 .255	5 .9±0 .255	6.3±0 .255
Mean diameter of a new culm per clump±S.E.	1 .13±0 .0363	1 .22±0 .0363	1 .33±0 .0363	1 .32±0 .0363	1 .41±0 .0363

Table 14 : Mean production of new culms per clump and mean diameter of the new culms for clumps obtained by different methods of raising.

Methods of raising	Forest transplants (X)	Seeds sown (Y)	Rhizomes planted (Z)
Mean number of new culms per clump ± S.E.	6.6±0.194	4.1±0.215	5.1±0.186
Mean diameter of a new culm per clump ± S.E.	1.24±0.028	1.19±0.031	1.40±0.027

Table 15: Yield of culms per clump at each cutting under the various treatments.

Treatment. \ Year	1937	1940	1943	1946
A	19.8±2.17	17.6±1.55	14.8±2.16	12.6±2.15
B	25.4±2.17	17.5±1.63	12.5±2.19	9.7±2.27
C	20.5±2.17	18.6±1.55	15.8±2.12	14.2±2.08
D	20.2±2.17	20.2±1.55	18.4±2.09	18.0±2.11
F (Control)	..	..	..	..

General Conclusions:— The general indications of the above experiments are,—

1. Treatment A (cutting one half the total number of mature culms around the periphery) and B (cutting one half the number of all culms, both new and mature, around the periphery) are found significantly inferior to the other treatments as regards both number of new culms and their diameter. Treatment B may result in the decrease of diameter of the bamboos. It has to be added that this treatment has resulted in the death of 4 clumps, a significant number, compared to zero under treatment A and 1 each under the treatments C, D and F.

2. As regards the number of congested clumps treatment C (cutting one half the total number of mature culms along the periphery at heights of (4½ to 5½ ft.) is comparatively the most unfavourable. This is probably due to the mechanical obstruction offered by the stumps of the cut culms.

3. Taking all factors into consideration, namely, congestion, number of new culms and their diameter and yield, treatment D has given the best results, and except from point of view of congestion this treatment is not significantly better than treatment F (control). It is therefore open for consideration if departmental working of bamboos, which alone can ensure a satisfactory D treatment, is really worth the trouble.

4. The control clumps (F) though 90 per cent congested after 19 years of growth, were not singnificantly inferior to clumps under any other treatment both as regards number of new culms and their diameter.

5. **Hereditary factors.**—The percentage of congested clumps in the (Y)-set of clumps (raised by sowing seed obtained from a 100 per cent congested area) has increased during the observation period from 0 to 12 inspite of the cutting treatments, and this seems to point out the influence of heredity on congestion. In the case of clumps raised from transplants (X) and rhizomes (Z) the cutting treatments have tended to progressive dimunition of the percentage of congested clumps, more or less in the same ratio for both.

6. From the curves 1 (a) and 1 (c) of Enclosure No. 5 we find that in the case of all treatments and also all methods of raising, culm production was highest after the second treatment in 1937, and then it went on decreasing till 1946. Similarly the diameter of the culms also improved up to 1940 after which it began to reduce gradually as the curves 1 (b) and 1(d) indicate.

Criticism:—The value of these results is greatly diminished on account of the fact that the clumps under treatment, though apparently comparable, are not essentially so on account of the following reasons:—

(i) They were raised by three very different methods, some from seed, some from natural forest seedlings about 3-year old at the time of planting, and some from rhizomes which were 12 to 13 years old at the time of planting. The method of regeneration was thus both sexual and asexual.

(ii) They were of very dissimilar age at the time of starting the experiment in 1934, the clumps from seed being only 7 years old, those from forest seedlings 10 years and the ones from

rhizomes being 19 to 20 years. The clumps from seeds and seedlings were therefore immature at the time of the first treatment in 1934, and those from seeds perhaps also at the time of the second treatment in 1937.

(iii) The clumps were of very different hereditary stocks, the seeds being from 100% congested clumps, the forest seedlings from a congested area where the clumps had flowered but not a 100% congested area, while the rhizomes were from 12 to 13 years old uncongested (normal) clumps.

By merely randomising the treatments among the three sets of clumps which differ from one another in origin, age and methods of raising, one cannot eliminate the influence of their essential incomparability. For example, inspite of the uniform treatment undergone by all of them, the dissimilarity in their age has found expression by almost all the (Z) - clumps, which are now about 35 years old, flowering gregariously and dying during the cold weather of 1949-50, while those of the other two categories (X) and (Y) are still young and fresh there being no symptoms whatsoever of any approaching seed production on them.

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ENCLOSURE No. 1.

PLOT CHART

Origin	Clump numbers and treatments																									
Transplants from congested clumps.	16 B	X	X	15 E	14 C	13 A	X	X	12 F	11 C	10 C	9 A	8 D	7 F	X	X	6 E	X	X	X	5 E	4 A	3 E	X	X	2 F	1 D
	X	X	X	17 B	18 B	X	X	19 F	20 B	21 E	X	X	22 D	X	X	X	X	23 D	24 C	X	X	X	X	X	X	25 C	X
	X	X	X	X	X	32 C	X	X	X	X	X	31 E	X	X	30 C	X	X	X	29 E	28 E	X	X	X	27 B	X	26 A	X
	33 D	X	34 F	X	35 B	X	X	36 B	X	X	X	X	X	37 A	X	X	X	X	38 B	X	X	X	X	39 D	X	X	X
	49 A	X	X	48 D	X	X	X	47 B	X	X	46 D	46 D	X	X	44 F	X	X	43 A	42 C	X	41 F	X	X	X	X	X	40 F
	50 E	X	51 A	52 B	53 E	54 A	55 A	X	X	56 C	57 A	58 C	X	X	59 F	60 F	61 B	X	X	62 F	63 E	64 D	X	X	65 C	X	66 D
Raised from seed from a 100% congested area.	77 F	76 D	X	X	75 F	74 A	X	X	73 C	X	72 A	X	71 B	70 F	69 D	X	X	X	X	68 E	X	X	X	X	67 E	X	X
	78 C	X	X	X	79 A	X	X	X	X	80 B	X	81 E	X	82 B	X	X	X	X	83 F	X	84 C	X	X	85 D	X	86 B	X
	X	X	X	X	95 A	X	94 D	93 F	X	X	X	92 A	91 B	X	X	X	X	90 E	X	X	X	89 C	X	X	X	88 A	87 F
	96 E	X	X	X	X	X	97 D	X	X	X	X	X	98 B	99 E	X	X	X	X	X	100 A	101 C	X	X	102 D	X	X	X
	X	X	108 A	X	X	X	X	X	107 C	X	X	X	X	X	X	X	106 E	X	X	X	X	105 D	X	104 B	X	103 C	X
	109 F	X	X	X	110 F	X	X	X	X	111 C	X	112 B	113 D	X	114 E	X	X	115 B	X	116 C	117 F	X	118 E	119 A	X	X	120 D
Rhizomes from uncongested clumps.	132 D	131 E	X	X	130 B	X	X	129 C	128 B	127 B	X	X	126 F	125 C	X	X	X	124 D	X	123 E	X	122 C	X	X	121 C	X	X
	133 E	134 D	135 E	136 E	137 E	138 C	139 A	X	X	140 D	141 C	142 D	143 F	144 F	145 C	X	X	X	146 B	X	147 D	148 B	X	149 B	X	X	X
	163 A	X	X	162 C	X	X	161 E	160 A	X	159 A	158 B	157 F	X	X	X	156 A	X	155 F	154 E	153 E	X	152 B	X	X	X	151 A	150 D
	164 F	X	X	X	165 B	X	X	X	166 D	X	167 F	X	X	X	X	X	168 A	X	169 B	X	X	X	X	170 D	171 B	X	172 C
	X	X	179 A	X	178 B	X	X	X	177 D	X	X	X	176 C	X	175 E	X	X	174 A	X	X	X	X	X	173 F	X	X	X
	X	180 F	181 A	X	X	182 D	X	183 E	X	X	184 E	185 A	186 F	X	X	187 C	X	188 D	189 F	X	X	190 F	X	X	191 A	X	192 C

Enclosure No. 2.

Frequencies of clump conditions for the different treatments and the three methods of raising for various years of treatment.

Clumps obtained by transplanting wildlings

Year	1934		1937		1940		1943		1946	
Condition Treatment	Uncon-gested	Con-gested	Uncon-gested	Con-gested	Uncon-gested	Con-gested	Uncon-gested	Con-gested	Uncon-gested	Con-gested
A	4	7	6	5	10	1	8	3	10	9
B	4	7	9	2	9	2	6	5	10	1
C	4	7	7	4	10	1	4	7	10	1
D	4	7	9	2	10	1	10	1	10	1
F	4	7	7	4	9	2	3	8	3	8

Clumps obtained by sowing seeds

A	9	0	9	0	9	0	9	0	9	0
B	9	0	9	0	9	0	5	0	5	0
C	9	0	9	0	7	2	5	4	6	2
D	9	0	9	0	9	0	9	0	9	0
F	9	0	9	0	9	0	3	6	6	3

Clumps obtained by planting rhizomes

A	6	6	7	5	10	2	5	7	11	1
B	6	6	8	4	12	0	9	3	12	0
C	6	6	8	4	10	2	3	9	9	3
D	6	6	11	1	12	0	11	1	10	1
F	6	6	8	4	10	2	0	11	6	5

Mean number of new culms per clump

Year	Treat-ment	Wildlings transplanted											Total	Seeds sown									Total	Rhizomes planted												Total	Grand total	Mean
1934	A	0	4	17	7	2	2	13	0	0	2	0	47	0	0	1	8	3	1	0	4	5	22	1	1	1	0	0	0	3	4	0	3	7	4	24	93	2.9
	B	12	5	4	0	5	9	8	2	0	0	2	47	0	0	3	6	2	2	2	3	1	19	4	5	1	2	3	3	0	0	0	4	0	2	24	90	2.8
	C	10	10	9	8	2	1	0	4	0	4	1	49	0	3	3	5	0	9	0	1	1	22	6	4	2	2	0	3	0	0	0	4	0	5	26	97	3.0
	D	14	8	0	6	5	4	2	4	2	0	1	46	4	0	0	0	3	2	4	5	2	20	1	11	3	0	3	0	0	1	1	1	1	3	25	91	2.8
	F	3	16	7	4	4	6	0	0	4	0	3	47	1	1	0	0	4	5	6	4	2	23	2	1	0	0	1	4	0	0	8	1	5	2	24	94	2.9
1937	A	7	5	19	16	2	5	17	6	5	5	8	95	7	4	5	11	4	8	4	9	4	56	2	8	2	7	4	2	9	7	6	23	10	13	93	244	7.6
	B	27	10	5	5	7	22	17	6	7	15	7	128	7	12	0	8	6	3	4	3	1	44	10	9	6	2	5	7	7	4	8	4	4	8	74	246	7.7
	C	14	15	8	8	5	12	14	6	9	11	5	107	10	15	3	4	11	12	8	3	5	71	11	8	4	8	9	6	4	6	13	8	6	20	103	281	8.8
	D	23	14	8	6	14	4	11	7	14	7	10	118	3	7	8	5	7	3	6	8	8	55	9	24	7	6	8	5	15	7	4	7	12	6	110	283	8.8
	F	10	15	10	12	8	13	8	3	14	8	8	109	6	9	6	8	10	7	5	10	9	70	15	7	8	6	7	8	2	5	16	11	11	9	105	284	8.9
1940	A	8	3	17	12	3	7	15	2	5	3	1	76	7	5	3	4	3	5	6	6	3	42	2	8	0	4	2	1	5	2	3	23	6	10	66	184	5.8
	B	21	5	2	2	4	14	14	3	2	7	4	78	4	5	1	6	6	0	0	1	0	23	8	6	1	1	3	3	4	1	5	3	4	6	45	146	4.6
	C	13	5	8	6	4	9	7	7	10	6	4	79	0	11	3	4	3	13	3	1	3	41	9	6	2	7	10	3	4	4	14	6	4	17	86	206	6.4
	D	21	13	5	6	11	4	10	6	12	4	7	99	4	8	6	2	5	3	2	7	2	39	6	25	9	5	4	3	4	5	3	4	4	5	77	215	6.7
	F	5	10	10	7	6	12	6	2	14	9	5	86	4	11	5	8	11	4	3	6	7	59	12	3	5	5	7	5	2	6	10	7	8	11	81	226	7.1
1943	A	0	1	13	15	2	8	4	2	2	1	3	51	5	3	2	3	5	4	3	4	3	32	0	9	1	4	2	0	4	4	3	25	3	12	67	150	4.7
	B	16	2	2	2	2	5	6	5	4	1	4	49	1	3	1	3	4	0	0	1	0	13	2	6	1	2	2	3	3	2	4	2	4	5	36	98	3.1
	C	11	4	6	5	3	9	6	8	6	6	2	66	0	7	4	3	5	13	3	3	2	40	13	8	3	6	6	3	3	3	16	5	4	17	87	193	6.0
	D	30	8	5	6	11	4	8	4	11	6	6	99	5	4	8	3	6	2	6	8	2	44	8	21	9	6	4	0	7	5	0	4	3	6	73	216	6.8
	F	10	17	20	13	4	16	6	1	6	5	3	101	2	3	4	9	20	2	4	3	7	54	9	3	4	5	0	6	1	3	10	4	5	12	62	217	6.8
1946	A	0	0	7	5	2	4	3	0	1	0	1	23	3	2	2	4	2	0	2	3	1	19	0	5	0	3	0	1	1	0	1	24	3	9	47	89	2.8
	B	10	1	1	1	1	4	5	4	4	1	1	33	1	3	1	2	1	0	0	0	0	8	3	1	0	1	3	3	2	1	2	1	4	1	22	63	2.0
	C	5	0	4	4	3	7	5	5	1	4	1	39	0	8	1	1	0	9	2	1	1	23	9	5	2	3	5	5	2	2	15	2	2	16	68	130	4.1
	D	16	5	7	4	9	4	2	3	10	2	2	64	1	2	5	1	5	2	2	3	2	23	4	23	6	5	4	1	3	2	0	1	2	7	58	145	4.5
	F	6	18	18	10	5	6	4	0	3	4	3	77	3	5	5	5	18	3	5	3	10	57	2	3	6	1	0	11	1	4	9	7	7	8	59	193	6.0
Total													1813										919													1542	4274	5.3

ENCLOSURE No. 4

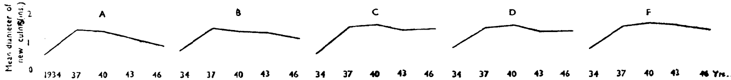
Mean Diameter of new culms in inches

Year	Treatment	Wildlings transplanted	Total	Seeds sown	Total	Rhizomes planted	Total	Grant Total	Mean
1934	A	0 1.3 1.2 1.1 1.4 1.2 0.9 0 0 0.9 0	8.0	0 0 0.9 1.0 0.9 0.9 0 1.3 0.9	5.9	1.4 1.4 1.4 0 0 0 0.9 0.9 0 1.4 0.8 1.1	9.3	23.2	0.73
	B	1.1 1.2 1.0 0 1.2 1.3 1.2 1.4 0 0 0.9	9.3	0 0 0.9 0.9 0.9 0.9 0.9 0.9 0.9	6.3	1.4 1.2 0.9 1.2 1.4 1.4 0 0 0 1.0 0 1.4	9.9	25.5	0.80
	C	1.4 1.0 1.0 0.9 1.2 1.4 0 0.9 0 0.9 0.9	9.6	0 0.9 0.9 1.3 0 1.0 0 0.9 0.9	5.9	1.1 1.4 0.9 0.9 0 1.4 0 0 0 1.0 0 0.9	7.6	23.1	0.72
	D	1.2 1.3 0 1.2 1.4 1.1 0.9 0.9 0.9 0 1.4	10.3	1.1 0 0 0 0.9 0.9 0.9 0.9 1.2	5.9	1.4 1.4 1.2 0 1.2 0 0 0.9 0.9 1.4 1.4 2.1	11.9	28.1	0.88
	F	0.9 1.1 1.3 1.4 1.0 0.9 0 0 1.3 0 0.9	8.8	1.4 1.4 0 0 1.3 0.9 0.9 0.9 1.2	8.0	1.4 0.9 0 0 1.4 1.4 0 0 1.4 0.9 1.1 1.4	9.9	26.7	0.83
1937	A	1.3 1.3 1.5 1.5 1.5 1.6 1.3 1.1 1.1 1.3 1.2	14.7	1.4 1.3 1.2 1.4 0.9 1.3 1.6 1.7 0.9	11.7	2.1 1.8 1.5 1.3 2.0 1.8 0.9 1.1 1.6 2.0 1.5 1.7	19.3	45.7	1.43
	B	1.5 1.6 1.6 1.7 1.5 1 3 1.7 1.7 1.5 1.3 1.6	17.0	1.4 1.4 0 1.1 0.9 0.9 0.9 1.1 1.5	9.2	1.9 1.8 1.5 1.5 1.5 1.8 1.6 1.3 1.7 1.3 1.6 1.9	19.4	45.6	1.43
	C	1.9 1.5 1 5 1.3 1.3 1.9 2.0 1.5 1.5 1.3 1.2	16.9	1 2 1.5 1.5 1.5 1.3 1.2 1.2 1.3 1.0	11.7	1.8 1.8 1.0 1.8 2.0 2.0 1.5 1.8 2.1 1.5 1.5 1.6	20.4	49.0	1.54
	D	1.6 1.7 1.5 1.6 1.5 1.3 1.3 1.4 1.1 1.1 1.3	15.4	1.5 1.6 1.6 1.3 1.5 0.9 1.2 1.1 1.2	11.9	1.7 2.1 2.0 2.1 1.5 1.1 1.5 1.5 1.3 1.5 1.3 1.9	19.5	46.8	1.46
	F	1.5 1.5 1.9 1.7 1.5 1.6 1.9 1.1 1.5 1.3 0.9	16.4	1.2 1.1 1.8 1.2 1.9 1.4 1.5 1.2 1.3	12.6	1.9 1.3 1.5 1.6 2.0 2.1 1.2 1.5 2.1 1.7 1.3 1.8	20.0	49.0	1.54
1940	A	1.6 1.1 1.5 1.7 1.5 1.6 1.3 0.9 1.0 0.9 0.9	14.0	1.3 1.2 1.9 1.6 1.1 1.5 2.0 1.9 0.9	13.4	1.5 1.7 0 1.5 1.2 2.1 0.9 1.2 1.7 2.0 1.4 1.8	17.0	44.4	1.39
	B	1.6 1.7 1.5 1.2 1.5 1 0 1.1 1.1 1.5 1 2 1.0	14.4	1.5 2.1 1.5 1.1 1.2 0 0 1.5 0	8.9	2.1 1.6 2.1 1.5 1.9 2.1 1.5 2.1 2.0 1.1 1.0 1.8	20.8	44.1	1.38
	C	1.9 1.5 1.5 1 5 1.3 1.8 1.5 1 5 1 2 1 3 1.0	16.0	0 1.8 1.9 1.5 1.5 1.6 1.0 1.5 1.1	11.9	1.9 1.9 1.2 2.1 2.1 2.1 1.8 2.1 2.1 1.5 2.0 1.8	22.6	50.5	1.58
	D	1.8 1.5 1.7 1.6 1.6 1.0 1.3 1.2 1.3 1.3 1.4	15.7	1 8 1.9 1.2 1.8 1.7 0.9 1.5 1.5 1.8	14.1	1.9 2.1 2.0 2.1 2.1 1.1 1.5 2.0 0.9 1.6 1.2 2.1	20.1	50.4	1.58
	F	1.6 1.8 1.7 1.9 1.4 2.0 1.2 0.9 1.5 1.3 0.9	16.2	1.5 1.9 2.0 1.6 2.1 1.3 1.7 1.6 1.7	15.4	2.1 1.5 2.1 1.2 2.2 2.2 0.9 1.5 2.1 1.9 1.3 2.0	21.0	52.6	1.64
1943	A	0 0.9 1.3 1.4 1.5 1.4 0.9 0.9 1.2 0.9 0.9	11.3	1.3 1.5 1.5 1.3 1.2 1.3 1.5 2.0 1.1	12.7	0 1.5 0.9 1.2 1.5 0 1.0 1.2 1.3 1.9 1.1 1.3	12.9	36.9	1.15
	B	1.4 1.5 1.5 1.2 1.8 1.2 1.0 1.1 1.3 1.5 0.9	14.4	2.1 1.9 2.1 0.9 1.0 1.6 0 0.9 0	10.5	1.5 1.1 1.5 1.5 1.5 1.9 1.5 1.5 1.3 0.9 1.3 1.5	17.0	41.9	1.31
	C	1.6 0.9 0.9 1.5 1.5 1.6 1.3 1.5 1.2 1.1 1.5	14.6	0 1.5 1.7 1.3 1.3 0 1.7 1.3 0.9	9.7	1.7 1.7 0.9 2.1 1.8 2.1 1.7 2.1 2.0 1.3 1.3 1.8	20.5	44.8	1.40
	D	1.6 1.3 1.3 1.5 1.7 1.3 1.0 1.5 0.9 1.4 1.3	14.8	1.5 1.5 1.5 1.3 1.6 0.9 1.2 1.2 1.2	11.9	2.0 2.1 1.8 2.0 1.3 0 1.4 1.5 0 1.5 0.9 2.1	16.6	43.3	1.35
	F	1.7 1.5 1.5 1.8 1.2 1.8 1.1 1.5 1.4 1.3 1.5	16.3	1.5 2.1 2.1 1.4 2.0 1.5 1.5 1.5 1.2	14.8	2.1 1.5 2.1 1.3 0 2.1 0.9 1.7 2.1 1.8 1.8 2.1	19.5	50.6	1.58
1946	A	0 0 1.4 1.5 1.8 1.4 1.0 0 1.4 0 0.9	9 4	0 9 0.9 1.8 1.4 1.2 0 1.4 1.6 0.9	10.1	0 1.2 0 1.2 0 1.4 0.9 0 1.4 1.8 1.2 1.4	10.5	30.0	0.94
	B	1.5 1.4 1.4 1.4 1.4 1 0 1.2 0.9 1.4 1.4 0.9	13.9	2 1 1.4 1.4 0 9 1.4 0 0 0 0	7.2	1.9 0.9 0 1.4 1.9 2.1 1.4 2.1 1.4 0.9 1.6 1.4	17.0	38.1	1.19
	C	1.3 0 1.4 1.3 1.2 1 7 1.5 1.4 0.9 1.1 0.9	12.7	0 1.6 2.1 1.4 0 1.5 2.1 2.1 1.4	12.2	1.8 1.9 0.9 1.9 1.7 1.7 2.1 2.1 2.1 1.8 1.4 1.5	20.9	45.8	1.43
	D	1.8 1.4 1.6 1.4 1.8 1.4 1.4 1.2 1 0 0 9 0 9	14.8	1.4 1.2 0.9 1.4 1.5 0.9 1.4 1.2 0.9	10.8	1.9 2.1 1.9 2.1 1.3 0.9 1.4 1.4 0 1.4 0.9 2.2	17.5	43.1	1.35
	F	1.5 1.3 1.9 2.1 1.3 1.6 1.4 0 1.0 1.8 0.9	14.8	1.4 1.7 2.1 1.4 1.8 1.4 1.4 1.4 1.5	14.1	0.9 1.4 2.1 0.9 0 2.0 0.9 1.6 2.1 1.8 1.5 2.0	17.2	46.1	1.44
Total			339.7		266.8		418.8	1025.3	

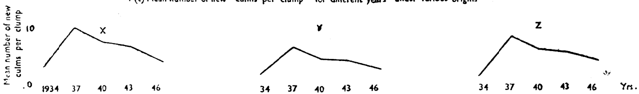
Enclosure No. 5

I (a) Mean number of new culms per clump for different years under various treatments

I (b) Mean diameter of new culms for different years under various treatments



I (c) Mean number of new culms per clump for different years under various origins



I (d) Mean diameter of new culms for different years under various origins

FOREST AND PHOTOGRAPHY

BY P.C. MUKHERJEE, ARTIST & PHOTOGRAPHER

(Contd. from May—1949 issue)

Procedure of development

As previously described, arrange three dishes on the developing table, — one for water, one for developer, and one for hypo. Take about 4 ozs. of the working developer in the developing dish. Break open the seal of the exposed roll film in the darkroom and separate it from its backing paper. Hold the film by its two ends and wet it out thoroughly (before development) by drawing its whole length to and fro in a "see-saw" manner, Fig. 1, through

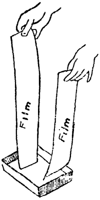


Fig 1

the dish containing water for about half a minute till limp. This ensures even development. When the film is perfectly limp, drain it for a moment and then introduce into the developer working the film in the same see-saw manner. If the film has been correctly exposed, the image will begin to appear within half a minute of the time of its immersion in the developer and gradually gain density. The development will be completed in about three to four minutes according to the temperature of the developer and the speed of the film. The higher the speed the longer the development required and *vice versa*. Correct development can only be determined by experience but generally it is stopped when the image becomes opaque and the high lights appear as black patches at the back of the film. The opacity is judged by holding the film to the light of the dark room lamp and *viewing through it*. During development the light of the lamp should be shielded by a piece of cardboard and development should be carried out at least two feet away from the source of light. However safe the light may be the film should never be exposed to its direct rays during the development except for brief examinations from time to time.

If the film has been over-exposed, the image will flash up quickly and if this happens, it should at once be taken out of the developer and immediately washed in plain water. A few drops of 10 p.c. Potassium Bromide solution (to be kept handy in the darkroom) should then be added to the developer and development continued till finished.

In case of an under-exposure, it takes a fairly long time for the image to appear and even then only the high lights will come up as black patches in the negative. In such a circumstance, the film should be removed from the developer and it should be diluted with twice its bulk of water. Development should then be continued till the negative has gained sufficient density all over.

When the development is complete, briefly rinse the film in water and place it in the fixing bath which may be plain, acid or acid hardening. The film is fixed in this bath till the milky appearance at its back disappears and the negative becomes transparent. To ensure a perfect fixation the film should be left in the fixer for some time more after its creamines has gone.

After fixing, wash the film in running water for about half an hour or in ten changes of clean water in a dish at an interval of three minutes. Drain the film and then hang it to dry in a place free from dust. To prevent it from curling a clip or a small weight should be attached to its botttom end.

In developing a glass plate or cut film it is placed in the flat bottomed dish, face upwards, and the developer is poured over it from another vessels taking care to cover the entire surface with one sweep. The dish is rocked so that the developer is kept in constant motion during development. Care should be taken to avoid any air bell sticking on the surface of the emulsion. If any air bell forms, it should be gently broken off with the tip of the finger.

Fixing, washing and drying are done in the same manner as described for a roll film.

It is of utmost importance to use freshly prepared developer, which, if compounded by the worker, should be filtered before use. Dishes fingers and measures etc. should all be kept scrupulously clean. Care should be taken to avoid contamination of the developer with hypo or other chemicals and for this purpose it is a wise plan to label the dishes at their sides with oil paint or use three enamelled bowls of different colours.

9. FORMULAE.

Negative Developers.

Fine-grain developer for Miniature and other High Speed Films.

No. 1.

Metol	.. 17½ grs.
Sodium Sulphite (Anhydrous)	.. 880 grs.
Hydroquinone. ..	.. 44 grs.
Borax	.. 70 grs.
Boric Acid	.. 70 grs.
Water to make ..	.. 20 ozs.

Use without dilution and develop for 10 to 15 minutes with constant agitation.

Note: This developer does not reduce film speed.

No. 2

Metol	.. 18 grs.
Sodium Sulphite (Anhydrous)	.. 876 grs.
Hydroquinone ..	.. 45 grs.
Borax	.. 18 grs.
Citric Acid ..	.. 17 grs.
Soda Sulphate (Crystal)	.. 876 grs.
Potassium Bromide ..	.. 2 grs.
Water to make ..	.. 20 ozs.

Use without dilution and develop for 10 to 15 minutes.

Note: It gives clear bright negatives of dicidedly greater contrast.

No. 3

Metol	.. 1 oz.
Hydroquinone ..	.. 17 grs.
Sodium Sulphite (Anhydrous)	.. 700 grs.
Borax	.. 45 grs.
Potassium Bromide ..	.. 2 grs.
Water up to ..	.. 20 ozs.

Use without dilution and develop for 10 to 15 minutes.

Note: Longer development in any fine-grain developer gives more contrast. Therefore, the higher the speed of the film, the longer the development required. Shorter development will produce *soft* negatives.
Longer development has a draw back that it tends to increase grain in the negatives. When bigger enlargements are contemplated care should be taken not to prolong development unduly.

No. 4

Fine-grain developer for Plates and Films.
(Metol-Meritol)

Metol	.. 20 grs.
Meritol Johnson's) ..	.. 120 grs.
Sodium Sulhpite, (Anhydrous)	.. 800 grs.
Water to make ..	.. 20 ozs.

Use without dilution and develop for 12 minutes at 65°F. May be rebottled for future use.

This developer is best suited for : Leica and other similar miniature films.

No. 5

High-temperature developer for Plates and Films up to 90° F.

Sodium Sulphite, (Anhydrous)	.. 1 oz.
Amidol	.. 60 grs.
Sodium Carbonate, (Anhydrous)	.. 1 oz.
Sodium Sulphate (Crystal)	.. 2-4 ozs.
Water up to ..	.. 20 ozs.

Smaller amount of Sulphate is necessary if the temperature is only 80° F.

It produces clean black negative of softer quality. It is suitable for all copy negatives except for those of line drawings.

The only draw back of this developer is that it does not keep and so should be prepared fresh when required. Even unused developer is spoilt if stored for three days.

No. 6.

Pyro-Soda developer for High Speed Plates and Films.

Solution No. 1.

Sodium Sulphite, (Anhydrous)	.. 240 grs.

Sodium Carbonate, (Anhydrous)	..	180 grs.
Potassium Bromide	.. ..	10 grs.
Water to make	.. ..	10 ozs.

The above solution keeps indefinitely in well stoppered bottle.

Solution No. 2.

Pyro Crystals	.. ..	40 grs.
Water to make	.. ..	10 ozs.

This has to be prepared fresh at the time of work.

For Normal Exposure. Take equal parts of each.

For Over-exposure. Take 2 parts of No. 2 and 1 part of No. 1 and add a few drops of 10% Potassium Bromide solution.

For Under-exposure. Take 2 parts of No.1 and 1 part of No. 2 and dilute with equal volume of water.

Pyro-Metol Developer for Under-exposed Plates and Films. This is a most energetic developer for use where gross under-exposure is suspected.

Solution A.

Metol	.. ..	35 grs.
Potassium Metabisulphite	..	100 grs.
Pyro Crystals	.. ..	100 grs.
Water to make	.. ..	20 ozs.

Solution B.

Sodium Carbonate (Anhydrous)	..	2 ozs.
Water to make	.. ..	20 ozs.

For use mix equal parts of A and B. To lessen the yellow stain add 1 Oz. of Sodium Sulphite, Anhydrous to B.

No. 8.

Metol developer for Copy Negatives.

Metol	.. ..	30 grs.
Sodium Sulphite, (Anhydrous)	..	190 grs.
Sodium Carbonate, -do-	..	160 grs.
Potassium Bromide	.. ..	10 grs.
Water to make	.. ..	20 ozs.

For use dilute with equal volume of water. This is intended for making *soft* negatives or positives from an over-hard original. Expose fully and develop for 2 to 6 minutes using a slow plate.

Note: This developer is not suited for copying line drawings in which case an M.Q. developer containing Caustic Soda should be used.

No. 9

Universal M.Q. developer for Bromide and Gaslight Papers.

Metol	.. ..	7 grs.
Sodium Sulphite (Anhydrous)	..	110 grs.
Hydroquinone	.. ..	27 grs.
Sodium Carbonate (Anhydrous)	..	180 grs.
Potassium Bromide	.. ..	5 grs.
Water to make	.. ..	10 ozs.

For Contrasty results, use without dilution.
For Softer results, use diluted 1 to 1.

Time of development. 1 to 2 minutes at 65°F.

No. 10

Another universal M.Q. developer for Papers.

Metol	.. ..	8 grs.
Sodium Sulphite, Anhydrous	..	175 grs.
Hydroquinone	.. ..	30 grs.
Sodium Carbonate, Anhydrous	..	120 grs.
Potassium Bromide	.. ..	5 grs.
Water to make	.. ..	10 ozs.

For Bromide Papers. Use 1 part solution and 1 part water.

For Gaslight Papers. Use undiluted.

Note: This is a softer developer than No. 9.

Time of Development 1 to 2 minutes at 65°F.

No. 11.

Amidol developer for Prints.

Sodium Sulphite, Anhydrous	..	219 grs.
Amidol	.. ..	50 grs.
Potassium Bromide	.. ..	10 grs.
Water to make	.. ..	20 ozs.

Dissolve the ingredients in the order given and use without dilution. Develop prints for 1½ to 2 minutes at 65°F.

It is the best developer for Bromide papers. Copy negatives on plates of 100 H & D. if developed in Amidol produce clean black negatives free from excessive contrast. This developer is also used for developing plates and films during summer to guard against freeling of the emulsion. *It does not keep.*

No. 12.

Soft Acting M.Q. developer for papers.

Metol	.. 27 grs.
Sodium Sulphite, Anhydrous	.. 180 grs.
Hydroquinone ..	.. 9 grs.
Sodium Carbonate, Anhydrous	.. 165 grs.
Potassium Bromide ..	.. 9 grs.
Water to make ..	.. 20 ozs.

Dilute 1 to 2 and develop for 1 to 2 minutes at 65°F. It gives " Blue-black " tone on papers.

No. 13.

Special developer for Gaslight papers in tropical climate.

Metol	.. 8 grs.
Sodium Sulphite (Anhydrous)	.. 262 grs.
Hydroquinone ..	.. 60 grs.
Sodium Carbonate, (Anhydrous)	.. 227 grs.
Potassium Bromide ..	.. 10 grs.
Water to make ..	.. 8 ozs.

For Normal results. Dilute 1 to 3

For Contrasty results. Dilute 1 to 1

Develop for 60 to 120 seconds at 65°F.

No. 14

M.Q. developer for Chloro-Bromide Papers.

Metol	.. 18 grs.
Sodium Sulphite (Anhydrous)	.. 220 grs.
Hydroquinone ..	.. 80 grs.
Sodium Carbonate (Anhydrous)	.. 160 grs.
Potassium Bromide ..	.. 18 grs.
Water to make ..	.. 20 ozs.

Note : The above developer can be used either undiluted or diluted with 4 parts of water, according to the tone desired, adding a few drops of 10 p.c. Bromide solution.

The print is slightly veiled in developing. It should be washed for 2 to 3 minutes in running water before fixing. The veiling clears out on fixing and full luciousness and beauty of the print is then seen.

The prints should be fixed one by one in a freshly prepared Acid-Fixing Bath. The fixation will be completed in about 4 to 5 minutes. *Longer soaking in the fixing bath will attack prints.*

No. 15

Developer for Warm tones in Bromide papers

Solution No. 1.

Hydroquinone ..	.. 200 grs.
Glycine	.. 80 grs.
Potassium Bromide ..	.. 80 grs.
Sodium Sulphite (Anhydrous)	.. 2 ozs.
Water up to ..	.. 20 ozs.

Solution No. 2.

Sodium Carbonate (Anhydrous)	.. 700 grs.
Borax	.. 219 grs.
Water up to ..	.. 20 ozs.

Use equal parts of No. 1 and No. 2 and equal part of water. Give full exposure and develop for about 10 minutes.

10. Retouching Negatives.

Retouching is the process of improving the negative by spotting out its defects by means of a pencil, knife or brush. The surface of the negative has to be prepared to give it a "tooth" by rubbing a little special medium (varnish) over the part to " take " the black lead. A piece of fine muslin is wrapped round the tip of the forefinger of the right hand and a drop of the medium (which is bought prepared) is soaked in it. It is then applied to the surface of the negative thinly and evenly in a circular action avoiding any hard line of the medium to be visible on the surface.

The retouching pencil must be of hard lead, such as, H.H. or H.H. H. and must be sharpened to a fine needle point by rubbing it on a fine glass paper. The pencil is used very lightly on the parts requiring retouching either in a circular action or with a loose dotting stroke making a series of tiny commas. The density is built up gradually by successive light strokes. If you see the pencil mark on the negative while working you should know that you are pressing the pencil hard. Spots, freckles and lines etc., on the face in a portrait are filled up and the texture of the skin smoothed considerably in

this manner. The pencil should be worked following the contours of the face and the direction of lines.

A test print should be made from the negative as a guide for the parts to be retouched. It should not be the idea to overdo the retouching by completely filling up all the transparent parts on the face in a portrait as in that case all character from the features will be removed. The beginner should better make an occasional rough print from the retouched negative to see the progress of retouching and if any portion is found unsatisfactory it can be removed by wiping the film with a piece of cloth moistened in turpentine and the process started again to that part.

Sometimes a sheet or two of white tissue paper is gummed at the back of a glass plate by the corners and the paper removed with the point of a sharp knife or safety razor blade from the dense part of the negative which require extra exposures to print them *e.g.*, a white dress or a blank sky. The lighter parts of the negative protected by the tissue paper naturally receive less exposure while printing than the parts from which the tissue papers have been removed. Thus a better print with details both in the shadows and high lights is secured (see printing) which otherwise would have been impossible.

The work is done on a specially constructed retouching desk which has a sloping board held in position by means of two metal struts which also allow it to be supported at different angles. A rectangular groove is cut in this board in which the negative is held face upwards in its carrier and a mirror or an opal glass is placed below the negative for reflecting light while working. It has also a drawer in the base for retouching requisites. The beginner can get a desk prepared locally of teak wood for a few rupees.

11. Notes on Filtering Solutions.

Miniature camera workers who want to make big enlargements from small negatives should use a fine-grain developer and filter it before processing the film. This will help them to avoid pinholes in the developed negatives.

In compounding the developer either distilled or boiled water should be used. Care should be taken to completely dissolve all the chemicals before filtering. The developer should be filtered into a wide-mouthed bottle by means of a glass funnel and filter paper.

The only drawback in using the filter paper is that the wet paper generally clings to the surface of the funnel and prevents an easy flow of the solution down the flute and so causes delay in filteration.

But this can be quickened if a lump of sterilized cotton wool is used instead of filter paper. The wool is first spread thinly and evenly on the palm and then placed in position in the funnel. The solution is then filtered through it. It takes only a few seconds to filter 16 ozs. to 20 ozs. of the solution by this method and the task of filtering no longer seems to be tedious.

Two or three folds of a piece of fine bleached muslin can also be effectively used if no cotton wool is obtainable.

The hydro solution should also be filtered before use to free it from grit or other hard particles which often scratch the surface of the film.

Undissolved chemicals cause spots in the negatives and prints and for this reason all developers should invariably be filtered before use.

While pouring out the filtered developer into the dish or tank care should be taken not to shake the bottle and not to use the last two ounces of the developer left in the bottle.

12. Printing Negatives on Bromide Paper.

Bromide Paper is a development paper coated with gelatino-bromide emulsion. It is used for the production of prints either by contact or by enlargement with artificial-or day-light. The tone in a bromide print may be black, white, sepia or any other such as brown-black or red. There are many varieties of bromide papers on the market with surface textures ranging from glossy to very rough so as to meet every requirement. The paper has also several grades—soft, normal, contrasty and extra contrasty—to suit negatives of different densities and contrasts. It is sold in various sizes both in packets and rolls. Packets of cut-size papers are convenient to use.

Glossy Papers are used for rendering fine details with brilliancy. That is why Amateurs' negtaives are generally printed and enlarged on a glossy surface.

Matt and Rough Surface Papers are best suited for portraitures and enlargements which require finishing.

Handling the paper.—The paper should be opened out of the packet and used in the darkroom before a yellow or orange light and the print should not be taken out to the white light until thoroughly fixed. The emulsion side of the paper is readily distinguished by its tendency to curl inwards when opened out of the packet and in case of doubt it is the best plan to nip a corner of the paper between the teeth when its sensitive side will stick to them. Great care should be taken not to rub the sensitive surface of the paper or to touch it with moist fingers.

Suitable Negatives and Papers.—Negatives of well graded contrasts, being neither too thin nor too opaque, are suitable for contact prints and enlargements.

For Normal Negatives —Use Normal papers.

For Flat Negatives, which lack in contrast, —Use Contrasty papers.

For Hard Negatives, in which high lights are too opaque and do not show details —Use Soft Papers.

Contact Printing.—The negative is put in the printing frame with its emulsion side facing upwards and a suitable mask is then positioned on it (to obtain white margin on the print). The paper is placed with its sensitive side in contact with the negative and the hinged back of the frame is then closed. The loaded printing frame is now taken out of the darkroom (covering the remaining papers) and exposed before a white light which may be either a lamp gas or electric light. The exposure varies on account of the following reasons :—

(*a*) Intensity of the light used for exposing the paper.

(*b*) Density of the individual negative.

(*c*) The distance from which exposure is made.

(*d*) The speed of the paper.

The speed of the paper varies with different make, hence it is always advisable to make test-prints for ascertaining the correct exposure required. To obtain uniform results, the same light should always be used and the same distance maintained during every exposure. The beginner should first of all classify his negatives in different groups, as explained, and make several test prints from each negative before finally printing it. The exposure should be made by holding the loaded frame before white light and counting (within one's self) 1.2.3.4 and so on with a measured beat. For a normal negative the exposure required will be about 5 seconds or 8 counts at a distance of 1½ feet from the light of a table lamp with oil burner. *Practising uniform countings dispenses with the use of a watch during exposure.*

Development.—After exposure the paper has to be developed in the darkroom in much the same way as the negative. Prints up to 8×6 inches can be placed dry in a developing dish and flooded at once with the developer. Large prints have to be soaked in plain water before pouring the developer on it. Smaller sizes can easily be slipped into the developer without being wetted. Care should be taken to avoid any air-bell sticking to the surface. If the print has been over exposed, the image will flash up quickly and soon get grey and veiled all over with no contrast. If, on the other hand, it is underexposed, the image appears too slowly and the shadows clog up with little or no detail in the high lights. It is only in a correctly exposed print the image appears gradually and finally develops with good gradations preserving the details in shadows, inter-tone and highlights.

PRINTING NEGATIVES ON BROMIDE PAPER.

Amidol Developer.

Amidol is decidedly the best developer for Bromide prints. It gives rich black tone and is easy to compound. The following is a good formula :—

Sodium Sulphite (Anhydrous)	..	219 grs.
Amidol ..	.. ..	50 „
Potassium Bromide ..	..	10 „
Water to make ..	..	20 ozs.

Dissolve the ingredients in the order given and use without further dilution.

The above developer is also suitable for developing plates and films during summer. It gives clean black negatives free from excessive contrast. The only draw-back of this developer is that it does not keep and so should be prepared fresh when required. Even an unused

developer is spoilt if stored for three days. It stains the fingers.

Those who prefer to use a Metol-Hydroquinone developer should use the formula No. 10 given in the chapter of formulae. This developer does not stain fingers and keeps well. It can be used for several prints. If stored in a bottle filled to the neck it keeps for several months.

Procedure.—The exposed paper is taken out of the frame and plunged in the developer. The dish is either rocked or the print turned over repeatedly in the developer during development. The image appears in about 15 to 20 seconds and gradually gains in density. The development should be complete in 1½ to 2 minutes, (practice determining time by counting uniformly) at a normal temperature of about 65 degree F. As soon as the print has been fully developed it should be taken out of the developer and thoroughly rinsed in clean water and then transferred to the Acid-fixing bath where it is left to be fixed for about 10 to 15 minutes. It is then washed for an hour in running water or several changes of clean water and finally hung up to dry.

A number of prints can be developed together by placing them in the developer rapidly one after the other and may be fixed in batches in the fixer. Care should be taken not to allow the prints to stick together in the fixing bath or else stain will result. They should be occasionally moved during fixation.

If the print has been made on a glossy paper, it should be taken out of the last wash water and squeezed to the ferroplate for glazing.

Improving Prints.—Sometimes the dense part of the negative, such as the sky portion, will require an extra exposure to print and this can be done by shading the remainder of the film after it has been exposed with a piece of cardboard and moving the cardboard to and fro to avoid any sharp line of shading appearing in the print.

Prints from a very harsh negative (such as a view of waterfalls) can be improved by the method known as a "Water-bath" method. As soon as the image appears, the print is taken out of the developer and gently slipped in the dish (face upwards) containing water. It is left there without agitation for about 10 seconds and then returned to the developer and developed for about 15 seconds more. The print is again taken out of the developer and slipped into the water. The process is repeated twice. After the final development the print is washed and fixed. When the print is slipped in the water it carries with a certain amount of the developer which in its diluted form helps the print to build in contrast producing details both in the shadows and highlights. A straight print from such a harsh negative may not be up to the mark.

The *success* in a bromide print depends chiefly upon:—

(*a*) Correct exposure.

(*b*) Safe darkroom light (which otherwise will fog the paper).

(*c*) Selection of the proper grade of paper.

(*d*) Clean and freshly prepared developer and hypo solution (stale developer produces muddy tone).

(*e*) Scrupulously clean dishes.

(*f*) Avoiding contamination of the developer with hypo and *vice-versa.*

Printing on Gaslight Paper.—Gaslight papers, such as, "Velox", etc. are about 60 p.c. slower in speed than Bromide papers. Owing to this reason they can be manipulated in an ordinary room by shielding the white light with a piece of cardboard or orange paper or fabric, the idea being to intercept the direct rays of the light acting on the paper and fogging it while it is being developed. No darkroom, is, therefore, required to print these papers and the worker will find his warm sitting room more pleasant and comfortable for this class of work than a cold darkroom. He can work while conversing with the other occupants of the room.

The electric table lamp should be placed on a table nearer one corner of the room about one and a half feet away from the wall and shielded. The developing and other trays should be arranged on another table about three feet away from the light. The loaded printing frame can then be exposed by holding it on the other side of the light (not intercepted) at a distance of about six to eight inches from the bulb and then developed in the shadow of the light with ease in the manner described under the Bromide Printing.

With this class of paper it is possible to make excellent prints from weak negatives which would otherwise have been impossible to print on any other paper. Owing to their slow speed these papers are especially adapted for making prints by contact.

There are four distinct grades of these papers to suit every class of the negative.

(*a*) Vigorous.	.. For weak negatives.
(*b*) Normal.	.. For normal negatives.
(*c*) Soft.	.. For hard negatives.
(*d*) Extra Soft.	.. For over-hard negatives.

They are supplied in packets of cut sizes with either Glossy, Semi-Matt or Dead-Matt surface to suit every taste.

Gaslight prints can be Sulphide toned if desired by the usual toning method.

13. TONING BROMIDE PRINTS.

Prints on Bromide paper will yield a pleasing Sepia tone if toned by either the " Suphide " or the " Hot Hypo Alum " method described below. In both the processes the tone obtained is permanent. Prints intended for colour finishing should first be toned to a sepia colour.

The Cream Crayon and Cream Chamois grades of papers are most suitable for sepia toning and the effect obtained with these papers is exceedingly mello and artistic. Prints on papers with white base can also be satisfactorily toned to a sepia image. Sepia prints last longer than the black and white images.

Sulphide Toning.—Prints intended for Sulphide toning should be correctly exposed, fully printed and thoroughly fixed in an Acid-fixing bath. They should also be well washed so that no trace of any hypo remains on them. Imperfect manipulation will give rise to an imperfect toning, such as, the formation of yellow patches which refuse to tone in the Sulphide bath. Blue spots occur in the toned prints due to the trace of iron in the tap water. Prints developed in Amidol tone richer than those developed in a Metol-Hydroquinone developer.

Procedure.—The washed print is bleached in the following bleacher.

Soln. A.	Potassium Ferricyanide..	40 grs.
	Potassium Bromide ..	60 grs.
	Water ..	10 ozs.

Bleach the print in the above solution till the black image disappears leaving a faint brown colour. Rinse it well in three changes of clean water and then transfer it in the solution containing

Soln. B.	Sodium Sulphide ..	40 grs.
	water	10 ozs.

When the toning has been completed, wash prints thoroughly well for about 15 minutes and then hang up to dry.

Note: Solution A should be stored in a coloured bottle and kept in the dark by wrapping a piece of black paper, around it, obtainable in the packet of bromide paper. It can be used over and over again till exhausted.

Solution B should be prepared immediately before use and thrown away after the day's work has been finished.

To avoid blister in hot weather, bleach the dried prints in the bleacher without wetting them previously.

Hot Hypo-Alum Toning.—Prints intended for toning by this method should invariably be hardened before use.

Take

Hot water	.. 20 ozs.
Hypo ..	.. $2\frac{1}{2}$ ozs.

Dissolve hypo by boiling in an enamelled dish and add in it gradually with constant stirring

Potash Alum	.. $\frac{1}{2}$ oz.
Sugar ..	.. $\frac{1}{2}$ oz.

A white scum will be found to form on the surface of the solution. This bath should not be filtered. It works better as it gets older. It may be strengthened from time to time by the addition of fresh solution. To ripen a new bath discarded prints should be toned in it before toning the final print.

Procedure.—Take the fixed and washed prints and place them one by one in the following solution made up of

Potash Alum	.. 1 oz.
Water ..	.. 20 ozs.

and harden them in it for about 10 minutes. Then rinse in a few changes of water and immerse them in the hypo-alum bath noted above and heat the bath to 120 degrees F (as hot as the hand can bear) keeping the prints moving in it till finally toned.

They will take about 30-40 minutes to tone. When toned, place them in a tepid alum solution of the following strength for 10 minutes and then wash thoroughly and dry, any deposit being wiped off with a cotton wool.

Alum ..	.. 1 oz.
Water ..	.. $1\frac{1}{2}$ pints.

Note: The hypo-alum bath when new tends to reduce the prints a good deal, and those intended for toning by this method should, therefore, be printed a shade darker. This bath is greatly improved by soaking a few pieces of P.O.P. paper in it before use. Stale papers will do.

The tone obtained by this method is much colder than that obtained by the Sulphide method. It is chiefly used by the commercial printers.

14. DRYING, TRIMMING AND MOUNTING OF BROMIDE PRINTS.

When the prints have been finally washed they should be taken out of the water and drained for a few minutes. Next the superfluous water from the both sides of the prints should be carefully mopped off with a piece of clean blotting paper or cloth and then laid face upwards to dry on a sheet of newspaper.

Larger prints are hung by twos (back to back) from a corner by means of wooden clips attached to a line of wire.

Glossy prints are squeezed on the ferro-plates for imparting extra lustre to them.

The prints should be left to dry in a place free from dust.

Dry-mounting process is the best for mounting the Bromide prints, but they can also be effectively mounted by the use of a good photographic mountant or starch paste. The print is first trimmed to the required size and the paste applied smoothly and evenly (free from any grit) to the back with the right palm of the worker, working from the centre of the print to the edges. The print is then carefully positioned on the mount, and a clean piece of white paper is laid on its surface and the print rubbed gently in contact with the mount. Next some books or magazines, larger than the print, are laid over it and the worker stands on them to give a firm pressure to make the print adhere to the mount all over. Any superfluous mountant or paste coming out at the edges due to the pressure imparted, can be wiped out with a clean piece of cloth moistened with water. Larger prints can, however, be advantageously soaked in water till limp, and the superfluous water blotted off before applying the stiff paste.

Preparing the Starch Paste.—Take a tea-spoonful of arrowroot and mix it finely with 4 ozs. of water in an aluminium bowl and then gently boil it to a transparent stiff paste with constant stirring. Drain the paste through a fine piece of muslin to free it from any grit and use when cold. Throw away the paste after the day's work is finished.

(*To be continued*)

MAN-EATER OF BINDAWAL

By Shri S. R. Daver,

Divisional Forest Officer, Bilaspur, Madhya Pradesh

(1) Mysterious disappearance of two men.—

(*i*) On 17th March, 1948, a fire-weatcher named Chamru Baiga, while passing through bamboo forest from Samardhasan to Talaidabra forest village, did not return to his place of residence at Samardhasan. Attempts were made to trace him out by beating the forest. A report of his disappearance was made to Police Station House, Pendra Road on 19-3-48. Local people in Lamni range have a superstition that there is an evil spirit in one of the hills which carries away lonely persons, and here the mystery of Chamru Baiga's disappearance ends.

(*ii*) One Dukalu Baiga of Bakal forest village in Kota Range is reported to be missing since May 1948. He was going from Bakal F.V. to Samardhasan and never returned home.

(2) An authenticated case of tiger killing a grazier.—On 20th October 1948 one Jungi, grazier of *daihan* cattle, was grazing his buffaloes at the junction of Lamni-Talaidabra-Chhaparwa road and Talaidabra-Samardhasan road. This junction of roads is one mile away from Talaidabra forest village and at this place Jungi and his brother smoked their *chongi* and parted—his brother with his herd wended his way to Talsidabra forest village and Jungi with his buffaloes proceeded to Samardhasan road just a few hundred yards from the juction at about 4 o'clock in the afternoon. After sunset some of Jungi's buffaloes returned to Talsidabra without him. The forest villagers of Talsidabra grew suspicious. On the morning of 21st October, '48 they made a search and found the evidence of struggle between the grazier and a tiger in the middle of the road. The villagers were able to reconstruct the following incident. Jungi's tragedy was the first authenticated case to solve the mysterious disappearance of men in the past. Instructions were issued that no one should travel alone in the infested area. For patrolling forest during the fire-season, firewatchers used to go in pairs.

(3) One pilgrim to Amarkantak missing.—

On 4-11-1948 two pilgrims (known as "*bawajee*") were seen at Katami forest village. They wanted to resume their journey to Amarkantak in the afternoon of 4-11-48. Forest villagers warned them that they would have to pass through the forest infested with a man-eater between Chhaparwa and Lamni and advised them to go the next morning. On the second day one of the pilgrims, instead of proceeding on to Amarkantak, rushed back to Bindawal in the opposite direction, and related to an old woman of Bindawal the tragedy of his companion being taken away by a tiger near Donkinakan *nala* not far from Chhaparwa forest village and near the village well. The pilgrim did not report the matter to the Police and his address is not known to any one.

(4) Man-eater proves to be a tigress.—

From the shape and size of the pug-marks the forest villagers recognised the brute to be a tigress, and henceforth this animal will be described as "she" and not "he" and as "tigress" and not "tiger".

(5) Man-eater takes buffalo kill.—In the first week of December 1948, permit holders occupied Sarasdol and Lamni Shooting Blocks. On the night of 6th December the tigress took the kill tied up near Talsidabra. Unfortunately the party did not beat the forest the following day. They had a beat on 8th December, when they drew a blank as the tigress was not in the beat. But forest villagers of Talsidabra could at once tell that the tigress which killed Jungi the grazier, also killed this buffalo.

(6) Man-eater kills Jethoo Bhumiya of Chhaparwa forest village.—(*a*) The grazier's lathi was found to be chewed up at one end with marks of tigerclaws on it. It appeared that Jungi must have used it for defending himself against the tiger's attack, as he held the reputation of being a very bold man. Many a time he had liberated his buffaloes from the jaws of tigers.

(*b*) His shoe was found at a distance, and it had tiger's hair-stuck on it, indicating that the struggling man used it for hitting the brute.

(*c*) The villagers followed the trail and found the victim's body about 200 yards away

from the road. The front portion of his chest and one hand had been eaten up. Thus they had sufficient evidence to state that the tiger was near about the victim's body.

(*ii*) **Villagers tie up the body on a tree.**—To preserve the body for Police *panchnama* the villagers took the body on an *amti* tree and tied it to a slanting branch with ropes made out of bark (*bakkal*).

(*iii*) **The tiger climbs the tree.**—The *amti* tree (*Bauhinia malabarica*) is 3 feet in girth, and of the slanting branch, (to which the body was strapped) the nearest end is 8 feet and farthest end 11 feet from the ground. The tiger visited this spot the same night, climbed the tree, untied the body and ate it up completely leaving very few bones behind not far from the tree. At this point I leave the story and quote an extract from my official report.

" At this stage, he is a man-killer but as he has eaten the victim's flesh twice, he may turn into a confirmed man-eater. Before this animal spreads terror into country side, it is essential to destroy it as early as possible."

The subsequent career of this brute proved that it created panic all over the Government forests.

On 19th March, 1949, one Jethoo Bhumiya, forest village Chhaparwa, went into the *bewar* (shifting cultivation) area to collect bark for making coarse rope. He was killed by the man-eater. As he did not return to Chhaparwa village, a search was made by the villagers. In the *bewar* they found Jethoo's axe, his dhoti, a dead puppy which was following him in his jungle excursions and a bundle of bark for rope making.

The range staff had a beat in this area on 23rd March, 1949. This was the fourth day and the tigress did not turn up in the beat. Although Jethoo was an old man of about 60 years, the man-eater left no trace of human flesh, only few bones and the skull were found in a *nala*.

(7) **Fire-watcher Maiku Gond, the sixth and the last victim.**—On 10-4-49 fire-watchers Maiku Gond and Parsadi Gond, both of Bindawal forest village in Kota range, started on patrol duty on Bindawal-Achanakmar forest road at about 9 A. M. They were going from Bindawal towards Achanakmar, sweeping and clearing dry leaves from the road. After doing their job over a length of quarter of a mile from Bindawal, they sat under a tree for a few minutes to chew tobacco and lime and then resumed their journey and work from Jhiria *nala*.

(*ii*) **Man-eater spies the fire-watcher.**—No sooner the fire-watchers resumed their work than the man-eater coming from the opposite direction spied one or both the men from a distance of about 200 yards. This was proved by a party of three men (a forester, a vendor and a villager) who were travelling on the road far behind the man-eater. Although the party did not see the man-eater they traced the pug marks of a tigress on a dusty road surface up to a certain point on the road.

(*iii*) **Man-eater stalks the quarry.**—As soon as the tigress located the men on the road, she entered the dense forest on her right side. She stalked them for some distance and reappeared on the edge of a forest road.

(*iv*) **Tigress lurks behind an ant hill.**—About 12 feet from the road, there is an ant hill ; here the tigress took up her position waiting for the unsuspecting men to appear on the road in front of her.

(*v*) **Position and movement of the two fire-watchers.**—When the tigress took up her position by the side of an ant hill, Parsadi was walking on the side of the road nearest the man-eater, whereas Maiku Gond was walking on the opposite side of the road and away from the brute. Parsadi Gond was walking about 40 feet behind Maiku Gond, and this position saved his life. Although he was nearer to the tigress than Maiku, due to the dense cover of trees on the edge of road, perhaps, the brute could not locate him.

(*vi*) **The man-eater springs on fire-watcher Maiku ; long jump and high jump.**—Between Maiku and the tigress, there is a sal sapling on the edge of the road, about 8 feet from the tigress's lurking place. When she sprang, the leading shoot of the sal sapling broke down at a point 4½ feet from the ground level. This was a high jump from a distance of 8 feet. On the other hand, the distance from the point to which the tigress sprang to the place where Maiku was walking is about 35 feet. This was the mean-eater's long jump (see Fig. 1).

MAN-EATER OF BINDAWAL

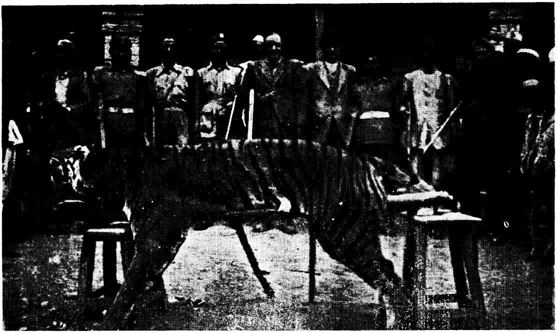
Figure. 1

Spot where the victim was standing.

Spot where the second fire watcher was.

Shri Daver, D.F.O. the tigress cleared the bush at his shoulder level.

The place where the tigress lay up.



Man-eater lying in state with armed guard and its assailant.

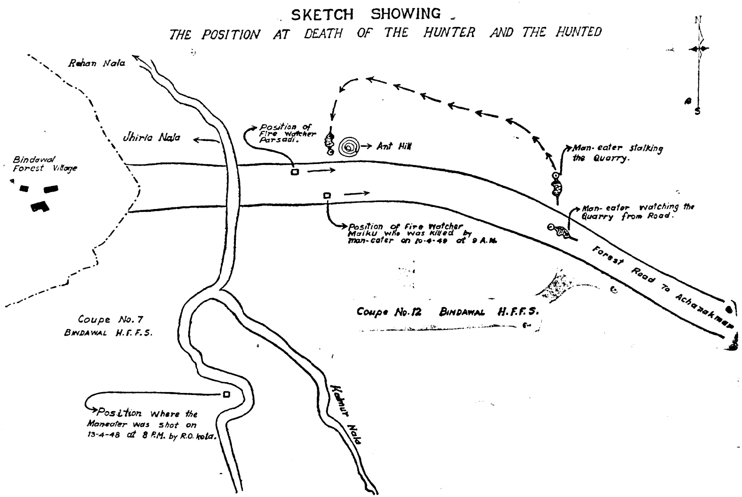

SKETCH SHOWING
THE POSITION AT DEATH OF THE HUNTER AND THE HUNTED
N
S
Rehan Nala
Jhiria Nala
Bindawal Forest Village
Position of Fire Watcher Parsadi.
Ant Hill
Man-eater stalking the Quarry.
Man-eater watching the Quarry from Road.
Position of Fire Watcher Maiku who was killed by man-eater on 10-4-49 at 9 A.M.
Forest Road To Achanakmar
Coupe No. 12 BINDAWAL H.F.F.S.
Coupe No. 7 BINDAWAL H.F.F.S.
Position where the Maneater was shot on 13-4-48 at 8 P.M. by R.O. kota.
Kalmur Nala

Fig. 2

(*vii*) **The tigress misses the target for a moment.**—

The tigress sprang with such force that she slipped past Maiku's neck and shoulder and landed on the other side of him, but within a fraction of a second she recovered her balance, turned round, rested her paws on Maiku's shoulder from behind, caught hold of his face and with one jerk twisted his head and face in the reverse direction. When this ghastly struggle was going on, fire-watcher Parsadi was hardly 40 feet behind the scene ; he said he was so close that he could hear the bone being broken, when Maiku's head was twisted.

Parsadi stated, he tried to scare away the man-eater by beating the axe-handle on the ground, but the brute growled ; so he ran back to his village Bindawal as fast as his legs could carry him and informed all the villagers about this tragedy.

(*viii*) **Forester, Licence Vendor and Villager.**—On the same day, a party of these three people with a pony was going from Achanakmar to Bindawal. On the way they sat down under a shady tree and started taking pan and tobacco, etc. They were behind the man-eater. Had they not stopped, it is just possible that the man-eater would have marked down one of them for her victim. However, this party could reconstruct the incident. As they advanced on the road, they found the pug-marks of the man-eater on the dusty road surface. At a certain point they could see that the tigress had entered the forest on her right. When they walked about 200 yards they saw on the road an axe, torn portion of a *dhoti* and a pool of blood. The blood was fresh and the villager accompanying the party gave a warning that it was dangerous to follow the blood trail in the forest.

(*ix*) **Villagers recover Maiku's corpse.**—About 300 villagers collected at Bindawal forest village and recovered the corpse of Maiku on the same day. Just like the Jungi grazier's corpse the man-eater had eaten the front portion of victim's chest and one hand.

(*x*) **Maiku's corpse tied up between two trees.**—The villagers selected two young trees, 17 feet apart. They strapped two stout bamboos on either side of the trees 15 ft. 2 in. above ground level. This formed a sort of a decking or let us call it a " bridge of sigh and sorrow" Over this " bridge " the villagers laid the remains of fire-watcher Maiku, and secured them with rope made of tree bark.

There was a two fold object in this arrangement. Firstly the villagers wanted the remains to be safe from the man-eater until police *Panch nama* was carried out. Secondly this arrangement also serves the purpose of a trap, if the tigress climbed the tree, when combined the following device :—

Bamboo stakes about 4 ft. in length were planted upright, the lower end of which was buried firmly 18 to 24 in. in the ground in dense formation, the spacing being 9×9 in. or 12×12 in. To the upper end of each stake, iron spikes or spear was inserted. The space below the " bridge " was covered with such iron spikes or spears. The outer margin of the area thus thickly planted with iron spikes was provided with simple pointed bamboo stakes in case the animal took a long jump from the tree. This method of killing tigers and mostly panthers is known as " *Soor Khel* " in Mandla district. If any tiger or panther attempts to jump from a tree with the kill in its jaws it is a sure jump for death.

(*xi*) **The man-eater climbs the tree**—The two trees which supported the decking or the " bridge " are a sal pole (*Shore robusta*) of about 20 in. girth and a *karra* (*Cleistanthus collinus*) pole of 19 in. girth at breast height. The outer dead bark of a *karra* tree is always very rough and strong. The man-eater very judiciously selected the tree for her climbing operation in order to secure a firm foot-hold. She climbed to 15 ft. 2 in. above ground level on this tree.

(*xii*) **Man-eater's miraculous escape from death**—When the Brute got on the sagging and swinging " bridge " she could not release the victim's body. The swinging motion of the elastic bamboos unbalanced her and she took a long jump away from the " bed of iron spikes ". However, one bamboo stake without an iron spike, on the outer margin, pierced the skin of the man-eater's neck. Unfortunately this stake was made of green bamboo ; it was not effective enough and bent down leaving only a scratch on her neck. With such punishment received on the night of 10th April she did not attempt to climb the tree again on 11th April. However, she did not leave this forest area.

(*xiii*) **Victim's body brought down on the third day**—On 12th April, 1949, the Forest Official M.W.K. reached the scene of the tragedy at Bindawal forest village. The villagers flatly refused to beat for this man-eater; they also refused to tie up a machan over the corpse.

In the end they agreed to bring the body down from the tree and, in case the man-eater dragged the body, they promised to beat the forest on the following day.

(*a*) The tigress visited the corpse on the night of the 12th and dragged it about 300 yards into a *nala*. The next day M.W.K. had an unsuccessful beat, as the beaters walked in single file formation instead of the usual method of spreading out and beating the bush.

(*b*) Further co-operation was refused. When the villagers found that the man-eater escaped from their "*Soor Khel*" trap and the beat organised on the morning of 13th April also drew a blank, they lost all hope of bringing this animal to book. On the contrary, they fully believed that the dead man's spirit will always guide the tigress for further destruction of human beings.

(*c*) They refused to tie up a machan near the kill and no one was prepared to sit with M.W.K. to flash the torch at night.

(*d*) One Bharosa, forest villager of Bindawal, took courage and promised to set with M.W.K. on the machan to help him. It was only then that the villagers prepared a machan near the corpse of Maiku Gond. The machan was put up at a height of 30 feet from the ground and just before sunset M.W.K. and Bharosa took their position on it.

(*xiv*) **The night of 13th April unlucky for the man-eater.**—Soon after the two men settled down on the machan, the villagers left for Bindawal ; subsequently it was found that the man-eater had followed their foot-steps up to the village boundary. The villagers believing in the spirit of the dead man urging the man-eater to guide it to get a fresh victim, came back to the machan and induced the shikari and his companion to get down. They were asked to go away.

At five minutes to 8 P.M. the man-eater came to the kill, picked up one end of the corpse and started walking. When she appeared at a clear, open spot, Bharosa flashed the torch-light and said loudly " there it is ". The tigress looked up to the machan, it is said, with Maiku's remains still held in her jaws. She exposed her left shoulder and a bullet from the D. B. 500 express rifle hit her behind the shoulder making a large exit on the opposite side. She " gave tongue " made a blind rush over a distance of 33 yards and then dropped dead.

(*xv*) **The causes for the tigress becoming a man-eater.**

(*a*) **Dental decay and deformity.**—On examination of the skull of the tigress it was found that the left canine tooth in the upper jaw was missing and there was a cavity in its place, and, to make matters worse, the right canine in the upper jaw was broken, leaving a small stump. The lower canine teeth were not broken on decayed, but were both blunt.

(*b*) **Porcupine quill wounds.**—When the tigress was skinned, five porcupine quills were extracted mostly from her front legs. One quill wound on the right and two or more on the left leg were festering.

Perhaps these deformities and wounds inflicted by the porcupine quills brought about complete disability for the tigress to obtain natural game ; hence she was driven to become a man-eater.

(*xvi*) **Reward for the destruction of the man-eater.**—The depredations of this tigress caused widespread panic and paralysed all the activities of Forest Department and of forest contractors. After the death of Jungi grazier, a reward of Rs. 100/- was announced for the destruction of this man-eater.

The Conservator of Forests, Eastern Circle, Madhya Pradesh, called on all the D.F.Os. to report on this important subject for further action. On 15th April, 1949 the following telegram was despatched to the Conservator : " Man-eater shot on human kill on 13th April."

(*xvii*) **Compensation to fire-watcher's relatives.**—Under the Workman's Compensation Act, a report was submitted to the Commissioner, Workman's Compensation, for further action.

(*xviii*) **Death of the hunter and the hunted.**

On 10th April, 1949, fire-watcher Maiku was killed by the man-eater. On the fourth day the man-eater was shot on Maiku's corpse.

(*xix*) **Strange behaviour of the man-eater.**

(*a*) Unlike other tigers and their tribe in general, this tigress could climb trees.* This was observed on two occasions. She was equally at home whether the tree was thick or thin, or whether her " kill " was tied up on the tree at a height of 11 feet or 15 feet from the ground. On rare occasions some tigers do climb trees—when they are

driven to do so by force of circumstances *e.g.*, tigers climb trees when chased by wild dogs.

(*b*) All tigers commence eating the rump portion of their victim, no matter whether the victim is a human being or a beast. But this tigress always started her meal at the front (chest) portion of her victim in the pantherine fashion. In fact I told my staff that from the mode of eating, the man-eater must be a panther ; subsequent events showed that I was wrong. This strange and peculiar habit may be due to the defective and missing fangs of the tigress.

(*c*) "Devil take the hindmost" is the principle, rigidly adhered to by the tiger tribe. If a string of carts are passing on a road, a cattle lifter would allow all but last cart to pass and attack the bullocks of the last cart. Similarly, if people are walking in the forest in a single file a man-eater would pick a man from the tail-end of the formation. But in the tragic scene of 10th April 1949, fire-watcher Maiku Gond was walking 40 feet ahead of fire-watcher Parsadi Gond, but the tigress sprang on Maiku Gond and killed him. There is a slight curve of the road where this tragedy occurred. When the tigress spied from the road, Maiku was walking on the outer curve of the road and his companion on the inner curve (about 40 feet behind). It looks as if the tigress was not able to see fire-watcher Parsadi walking on the inner curve of the road and she thought Maiku to be a lonely man travelling on the road ; hence she attacked and killed him.

(*) It is not very uncommon to find tigers climbing trees ; some tigers perch themselves on the trees adjoining game paths and jump down upon the unsuspecting prey which frequent such paths ; in fact this is one of the favourite methods of obtaining food without much trouble, by the bulkier animals of this kind.

(K. K.)

A TREK IN SIKKIM

By Shrimati Amiya Banerji

Picturesque Sikkim, a paradise for botanists and mountaineers, is also visited by lay people for the sake of mere adventure. Eastern Sikkim is the favourite of the less ambitious travellers, as it is easy to approach, and the Nathu-La pass (14,000 ft.) is frequently visited by people who wish to have an experience of mountain climbing with comparatively little trouble. In the whole of Sikkim there are many beautiful places to go to, and our trek in search of a suitable site for a high-level Research Station took us to the north of Sikkim. There, at every furlong we came across lovely and lofty water-falls, numerous orchids and diverse coloured flowers.

We were a party of ten, with an appropriate number of porters and mules for carrying our baggage and rations. Some of our party were on official duty, but many were mere holiday makers. We left Gangtok (5,500 ft.) the headquarters of Sikkim State, on a rather windy and cloudy afternoon after a disappointing wait for a few necessary articles which had not arrived from Siliguri, the railhead, due to breakdown of the lorry. Amongst the luggage left behind were the most essential beddings and clothes of some of the pleasure hunters. The whole party, except one, left for Dikchu (1,500 ft.) the day's destination 13 miles away. The one left behind went in a car in search of the missing luggage which, we were informed, was held up just outside the Sikkim border. He promised to join us at Dikchu that night. We marched gaily but those who were without their beddings walked rather dejectedly towards Penlung-La, a pass at 10,000 ft. height between Gangtok and the Tista valley. Towards late afternoon we were initiated to drenching rains and introduced to the numerous wriggling leeches which were to be our constant companions for a few days. Soon the sun disappeared behind sombre clouds and darkness set in rather early; fortunately this happened after we had crossed a fairly dangerous land-slide, which phenomenon was also to be our constant companion till we went to the higher regions. With the approach of unexpected, sudden darkness the leeches had a grand time with us, crawling all over our bodies and playing a merry hide and seek. The rain also joined in the game and we had a lot of fun that evening. We reached Dikchu fully drenched and were welcomed

Fig. 1

River Tista blocked by a landslide, formed into a lake.

Fig. 2

Lachen Valley below Thang.

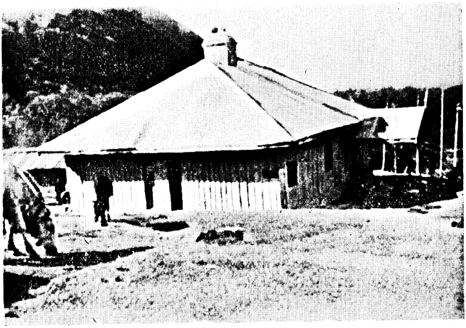


Fig. 3.

Thangu Bungalow (12,860 ft.)

Fig. 4.

Kanchanjha (22,509 ft.)

Fig. 5

Meandering Jhachu at 14,000 ft.

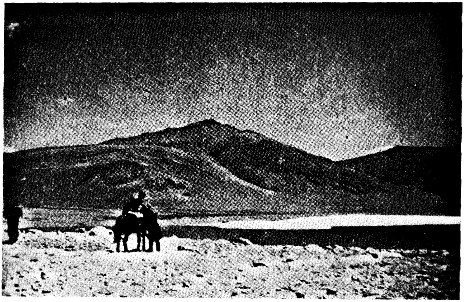


Fig. 6.

Lake at about 16,000 ft. below Chungakering.

by the advance kitchen staff with hot stimulants. After disengaging our selves from the slimy parasites we enjoyed watching the end of their lives in pure table salt. Then we set to thinking of Mr. Choudhury who was still on the road retrieving the missing luggage. We had lot of experience and his companion was the famous 'Everest Tiger' Aung Tarke; nevertheless, on that road with a very masty land-slide to negotiate in pitch darkness, it was quite dangerous and naturally we were anxious. They arrived at about 10 P.M., quite cheerful and none the worse for their adventure. We left Dikchu at 9 A.M. the next day for Singhik. The first two or three days of our journey were uncomfortable due to the daily drenching and the ever present leeches; but the scenery and the elemental, startling and changeful beauty of the places we passed through were much more than sufficient compensation.

We reached Chungthung, 13 miles from Singhik and 5,120 ft. high, on the third day of our march. The bungalow is situated at the confluence of the rivers Lachen and Lachung, the river below this being known as the Teesta (Fig. 1). The previous day's halt at Singhik had proved disappointing, as we had missed the famous view of the Kanchenjungha due to the clouds. From Chungthung the weather favoured us and we were free from the rains and, incidentally, also from the leeches. The march to Lachen was eventful. A member of the party had dreamt the previous night that he was watching his pony going down the hillside at a terrific speed and suddenly the scene changed and he found himself eating delicious strawberries. On our way, after we had covered about two or three miles, this member's horse slipped and fell while crossing a diversion. The rider was fortunately thrown away from the slope and missed a vicious kick from the horse by a mere fraction of an inch as it tried to regain its foot hold. The next instant he witnessed his horse rolling down the *khud*, a matter of 60ft. or so. Fortunately both of them escaped any serious injury. One was badly shaken by this unexpected fulfilment of part of his dream and the other, which we expected would probably have to be shot, suffered nothing more than two deep cuts near one eye. Within a few yards of the scene of this accident we came upon big red strawberries all over the hillside and thus the whole dream came true ! I wonder if the poor horse too had dreamt of its lucky escape !

Lachen, about 8,950 ft. high, is a fairly big village on a high river terrace. The steep slopes on either side are covered with towering trees of *Tsuga* and *Abies*, some of which are more than 100 ft. high and 10 ft. in girth (Fig. 2). All along the river bed the profuse growth of larch added a peculiar charm to the river. There is a Finnish Mission at Lachen and we visited the lady in charge. She herself happened to be a Latvian. She was the only so-called civilized person there and when we saw her she was down with fever and in bed. She had been having fever for sometime and was lying there without any medical help. We did all that we could with our medicines and the tinned food stuff we could spare to help her.

The journey from Lachen to Thangu (12,860 ft.), 13 miles away, was very tiring especially towards the end. We felt very heavy and short of breath as we came nearer to Thangu. Just below Thangu we passed through a natural Fairy-garden fully ablaze with Rhododendrons of various colours. Every bit of the open ground was covered with the queer-looking stems of *Ephedra*. There were numerous birch trees but these were being felled for cultivation. Every available bit of plain ground was being utilized for potato cultivation.

Thangu nestles in a sort of valley surrounded on every side with high, snow-covered peaks. No one lives here except the bungalow *chowkidar* and his family (Fig 3). Here nearly all of us got severe headaches, and I was down with mountain sickness for three days. My only consolation was the bungalow book, in which had been recorded that eminent and seasoned mountaineers like Smythe of the Mt. Everest Expedition had fared as badly as I at the same place. There were various theories explaining why this place, though at a comparatively low altitude, should produce such bad symptoms of mountain sickness but theories were of no use to me when I felt so miserable. One morning we went from Thangu towards Sebu-La pass (17,560 ft.) and obtained wonderful views of Kangchenjhau (22,603 ft. (Fig. 4) and Chomoiomo (22,403 ft.). Seeing these lofty snow-covered peaks so near and of such huge dimensions made one realise the vast ness of the place and forget the little difficulties of life. The broad and marshy valley of the meandering Jha-Chu looked like a flat lake bed (Fig. 5).

From Thangu the party went 12 miles up along a glacial valley at an elevation of 16,000 ft. just below Chungokering (18,050 ft.). The lake with its deep blue water, surrounded by snow-covered peaks, in the rolling Yetsemo

plains was really gorgeous to behold (Fig. 6). From here the Kongra-La pass (16,840 ft.) to Tibet is only two miles away. Though this country is politically in Sikkim, it has, presumably, geophysical affinities with Tibet. Here the party came across one or two tailless rats, marmots and three snow leopards. There were a few Tibetian tents close by, whose owners had come on their yearly visit to graze their yaks. They had donkeys and ferocious dogs with them. The Party camped at Donkhung village (16,000 ft). Next morning the inside of the tents was found decorated with tiny icicles while outside it was bitterly cold and windy. The climb to the 18,050 ft. peak was attempted and achieved by four members of the party. This peak has a flat top with a comparatively easy slope leading to it. The party was overjoyed to discover an ideal peak like this which they considered most suitable for a multi-purpose High Altitude Research Station.

On our way back we were more fortunate for we had no rain at all during our march and always reached our destination in comfort, but when we were safely in bed almost every night we heard the patter of rain outside. Near the streams we were still having it out with the leeches. Lalu Ganguly of Calcutta tried out various experiments on his boot with D.D.T. and salt to keep out leeches and discovered that the good old salt was much more effective than D.D.T. He was heard to voice his intention of patenting and producing a special kind of boots made with leather soaked and treated with a solution of salt for the use of the unfortunate travellers to Sikkim!

On our return journey we heard that the first three bungalows after Gangtok are haunted. In the first one the ghost is said to be harmless unless one ventures out alone at night. In the second place also the ghost is stated to be harmless, because he just-knocks at the door and invites you to witness his fruitless efforts to make a fire outside the bungalow. The third bungalow, where we did not halt, is supposed to be haunted by a really wicked ghost which tries to strangle unwary travellers. Fortunately, or rather unfortunately, I thought we had to be content only with stories.

As we walked down we were presented with a picture entirely different from the one we saw on our way up. This was due to the absence of the usual rains in these parts. Under the clear blue sky we could enjoy seeing the rivers flowing between high cliffs and the blossoms taking the opportunity of the rainless days to bloom gloriously all over the hillside. We met a few lone Englishmen and a French couple; the latter had come all the way from South India to attempt the Paunhari peak (23,385 ft.). An English professor was travelling in the real professorial way forgetting to bring with him even his tent?

There were numerous landslides due to the heavy rainfall which made the road difficult and dangerous. We met the Overseer and his staff repairing the bridge over Zehu river which had collapsed during a heavy snowfall in winter due to pilfering of the essential bolts and nuts by Tibetans. It had to be kept constantly repaired and cleared by the P.W.D. We heard of various accidents, some fatal, which had happened from time to time on different portions of this route. The Tibetans we met were very friendly and cheerful. They were healthy and sturdy. The watcher of the Thangu bungalow was being pensioned off as he had reached the pensionable age, but we saw him go down to Lanchen one evening and get back to Thangu early next morning to bid us good-bye. The next day we met him at Lachen again quite early in the day which made a trekking 40 miles of difficult hilly road within 24 hours. We were told he could walk to Gangtok in twelve hours, a matter of 62 miles of rough and dangerous hill path. Even so he had to retire.

At Lachen we went to the Mission Bungalow to enquire about the patient and found her still indisposed. We offered to take her back with us as we felt she should not be left there any longer without any kind of medical help but she did not want to leave her post. A month or two later I heard from her that she was well again and had gone to Lachung Valley which she liked much better than Lachen. We were back in Gangtok and so to civilization, after a very enjoyable and eventful three weeks in the back of the beyond.

EXTRACTS

SOIL EROSION IN CANADA

(*Evening Telegram, Toronto*)

In Northern Peel County and in some sections of Simcoe thousands of hardy pine trees have been planted this year by farmers who, heeding the advice given by Ontario Department of Agriculture, are waging a desperate fight against soil erosion in the province.

Here in Ontario, Department of Agriculture officials in conjunction with the Department of Lands and Forests branch are striving to educate the farmer and land clearer as to the proper methods of combating erosion, with sensible clearing of bush land, so that their land, while fertile now, won't become worthless in a few years.

Just one hour's drive from Toronto in Peel County one of the worst examples of soil erosion is to be found in the 'badlands' Cheltenham.

Here acres and acres of red clay deeply etched with gullies, some 23 feet deep, are to be seen, yet many years ago this was a thriving farm helping to supply the owner with bountiful crops and a livelihood. Now it is useless.

Just what has caused this area to become useless is not known. One theory is that the original owner plowed it up and down hill, allowing the spring floods and rains to follow the furrows gradually eating away the fertile top soil and exposing the red clay underneath. Now time and nature have taken their toll.

Many Years Needed.

Brace Beer, Peel County Agricultural Representative, who travels to all sections of the country and advises the farmers in soil conservation, said 'it would be very difficult to do anything with this piece of land, it is so badly gullied and eroded. If any effort was made to check the erosion by reforestation, it would be many years before any change could be noticed.'

Mr. Beer said the biggest project his department is now undertaking in regards to soil conservation is to convince the people who had never farmed before and were now doing so, not to cut down most of the trees on their farms.

"Many farmers have either sold their farms or their bushlots for clearing. This is not always wisely cut," he said "We try to point out or suggest the proper methods of land clearing".

Blow sand is another type of erosion that has taken its toll of farmlands in Ontario. Near Mac-Ville in Peel County, a 30-acre patch is being successfully fought by the Ontario government. Where there was once nothing but a miniature desert, now acre upon acre of pine trees have been planted to stop drifting soil. This land will again be fit for the raising of crops, only if the trees are cut so that a wind-break will stop the elements from blowing the soil away.

Due to Faulty Clearing.

"Blow sand is definitely caused by poor land clearing methods," explained Mr. Bear, "where the soil is light, trees have all been cut down allowing the wind to sweep in upon it and carry it away. First a tiny sand spot will appear then gradually get bigger and bigger year after year until at last all the exposed land is useless."

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* (From Zeitschrift für Weltforst wirtschaft; Internationaler Forstwirtschaftsbericht).

In Northern Peel around Palgrave many patches of blow sand are to be seen. Farmers taking the advice of the agricultural representative have planted row upon row of hardy pine trees.

Over the border of Peel in Simcoe Country, north of Ballycroy, are some of the largest patches of blow sand in this section of Ontario. Known locally as the "Sahara desert" this area is rapidly devouring many fine acres of farm land.

On the farm of Sam Mason, fence posts have been buried by the drifting soil. Board fences erected along the county road have been covered and on windy days the soil drifts upon the highway, partially blocking it to traffic. Dotted about are mounds six or seven feet high, with some grass growing on them. What fence posts are uncovered bear the marks of the drifting sand where it has even eroded the wood.

Some efforts of reforestation have been made, but even the hardy pines look as if the battle to stop the drifting soil is too much for them: they are stunted in growth, and barely holding their own.

Across the road vast expanses of white sand can be seen on the hillsides, rapidly devouring the surrounding land. Yet further back, a large stand of trees make a startling contrast. Here the soil is arable.

Three Doctors Aid Fight

Ontario government officials are not alone in their fight against erosion. At Guelph three doctors of the Homewood Sanatorium are hard at work on the problem of combating soil erosion.

Drs. F.H.C. Baugh, J.J. Goeghegan and D. Kennedy are experimenting in three different methods how to feed the soil so that it will bear crops to feed mankind.

Dr. Baugh, superintendent of the hospital, was awarded a cup by Wellington County for the best piece of reforestation carried out by an individual in the county. On his farm he has planted 20,000 young trees.

Dr. Kennedy, hospital bursar, is trying a different method on his 200-acre farm to prevent the flight of top-soil by spring rains. He plants rye in the fall. The soil clinging to the roots is not lost in the spring when the rye is plowed under.

Dr. Geoghegan is experimenting with compost heaps, into which all vegetable waste from the hospital kitchen and grounds are placed.

Copy English Ways

All three men have studied the ways of the English gardeners who save all their lawn clippings and other garden matter, converting it into rich fertiliser, by means of compost heaps, thence into the soil where it becomes an important part of the land.

In Western Canada, where soil erosion laid many a farm to waste and is still a major problem on the prairies, officials of the Dominion Experimental Farm at Lethbridge are advising farmers to seed the eroded gullies with grass.

Drainways on the station have been seeded on the sides and grass grown. It was found that hardly any runoffs of soil were noticeable. Brome grass or crested wheat grass were found most suitable.

And so the battle of erosion v. man goes on all across Canada. Where proper farming and cultivating methods are carried out, crops to feed Canadian are grown. Where haphazard methods are used, barren useles land results, gradually, like a fire, devouring all in its path.

TREES

BY ETHEL MENNIN

Some human beings, declare the trees, are pests, they cast a depressing shade over everything; they make the place damp with their clammy stupidity; everything flourishes much better without them. Some are in favour of cutting human beings down altogether; others, less radical, are content merely to prune them back, lopping an arm off here, a leg there; some even go so far as to lop the head off, and practically everyone is agreed that the hair

must be sheared away—since nothing should be allowed a free and flowing grace, and the more distorted and maimed the better.

The trees find it as unforgivable as unforgettable that in the old days human beings had a free hand with trees, and suburban dwellers were particularly addicted to the harbarous practice of mutilating trees. Some even appeared to work on the principle of " Here's a tree—let's cut down! "

It may be only an atrocity story, of course, but it is even said that in a London suburb a hulking brute of a man was seen to cut down a double-flowering cherry tree saying that it was only in bloom for a fortnight in the year, and the rest of the time darkened the drawing-room windows.... If the story is true—and the trees claim eye-witnesses—what the trees will do to that man if they ever catch up with him is beyond telling; pruning him back to the loins will be the least of it....

Deer Repellent Tests Are Showing Promise

(*Journal of Forestry*, *Vol. 47*, *No. 10.*)

The West Virginia Conservation Commission reported experiments during this past summer with a new deer repellent have shown promise of answering " limited needs " in protecting orchards and crops from deer. Tests are continuing and will be expanded to include buckwheat and nursery stock.

Known as Goodrite z.i.p., the repellent was developed by the Good-rich Chemical Company which released it for public use last May.

The experiments in West Virginia so far have been confined to orchards, wildlife plantings, and cauliflower and broccoli. In further experiments its effects in repelling rabbits and mice will be tested.

The repellent nature of the chemical is in taste and not odor. In an experiment on one orchard, 810 young peach trees were sprayed. A few weeks later a check showed that four deer had recently gone through the orchard without " seriously browsing " the trees. The spray still was adhering to the plants.

Use of z.i.p., said a report from field men conducting the tests, apparently " can be economically an effective deer repellent on young orchards and garden crops such as beans that do not possess extremely waxy surfaces. In West Virginia where the deer herd is continually on the increase, crop damages are expected to mount proportionately unless management is able to keep up-to-date and cope with the new problems as they are confronted. "

MILKING MARVEL TO BE INSTALLED

Feeds and Handles 50 Cows Simultaneously

Strict Hygiene Observed.

(*Austral News, Bombay*)

Third in the world and first in Australia, a 'rotolactor' is being installed at Camden Park Estate, of Manangle, New South Wales. This mechanical milking marvel handles 50 cows simultaneously on a rotating platform, and delivers the automatically-weighed milk through a stainless steel pipeline to the dairy plant.

The other two rotolactors are both in the U.S.

A Sydney architect, Mr. T.M. Maloney, was consulted on architectural angles. This is believed to be the first time that such an installation has been handled from the start as an architectural problem as well as one of mechanical installation.

Using Mr. Maloney's design, Bryant Brothers Pty. Ltd. Sydney dairy engineers, built in transparent plastic, models which were displayed at the 1950 Royal Easter Show in Sydney.

Excavations and other preparations for the rotolactor are already in progress.

Originally designed by Mr. Henry W. Jeffers, president of the Walker-Gordon Laboratory Co., of Plainsboro, New Jersey,

U.S.A., the rotolactor was first installed there in 1930.

The Gamden Park version calls for a rotating platform of 60 ft. outside diameter, providing bails for 50 cows all facing the centre. It will complete one revolution in approximately 10 minutes; it milks about 250 cows an hour.

Cows enter the rotolactor by a race and a foot-path. They are spray-washed and dried with a sterilised cloth and inspected by a trained attendant.

Fastened in the bails, they then have teat-cups attached and are automatically fed a measured ration of grain concentrate from overhead hoppers. They eat as the milking proceeds.

By the time the platform has made a full revolution, the cow is milked out.

Milk is released into a weigh-bowl and the weight recorded, and the cow is turned out on to a ramp which leads downwards and outwards through another race to the resting yards. The milk is collected in a receiver and pumped direct to the dairy.

Each bail is fitted with a hinged grating leading to a concealed drain through which manure is drawn by running water to a pit whence it will be taken as liquid fertiliser for the fodder-raising paddocks.

When the rotolactor is working, dairy cows will no longer wander at large in the field. They will be kept near the machine and hand-fed with fodder grown on land now used as pasture.

RICE CROP IS NEAR RECORD

(*Austral News, Bombay*)

Australia's rice crop this season may easily reach 70,000 tons, according to Mr. W.M. Curteis, senior agronomist of the New-South Wales Department of Agriculture.

Nearly half the crop had been harvested early in May, 1950, and indications were that it would exceed last year's 67,000 tons and come close to the all-time record yield of 75,000 tons of 1944.

Most crops already harvested have yielded more than two tons to the acre, many going up to three tons. The average so far for the Murrumbidgee Irrigation Area, the principal production centre, is about 1.78 tons per acre.

After the next crop is harvested, the Federal Government will consider whether it is possible to abolish the ban on the sale of rice in Australia.

Minister for Commerce and Agriculture, Mr. McEwen, said he had been informed that more rice was becoming available in certain Asian countries. In fact, Australia had been offered supplies from Burma and Indo-China.

Whether rice could again be sold to the general public of Australia depended, however, on the extent of the next rice crop.

(Though Australia grows enough rice to meet the fairly small domestic demand, housewives have been unable to buy rice in the shops for the last eight years, as almost the whole of the crop is made available to Asian countries.)

SEAWEED MAY EARN DOLLARS

(*Austral News, Bombay*)

Philippine fisheries experts are considering buying bulk supplies of Australian seaweed, reports the Sydney *Daily Telegraph*, quoting Dr. D. Villadolid, Philippine delegate at the annual conference of the Indo-Pacific Fisheries Council.

Dr. Villadolid said manufacturers in the Philippines needed more seaweed for the production of stock feed. The manufacturers used several species of seaweed as the source of food for both humans and farm animals.

Supplies were difficult to obtain of the kelp type of seaweed that grew in Ocean water of the Southern part of Australia, Dr. Villadolid said.

" I am anxious to get as much as possible of the kelp type of seaweed ", he added. " If the price is acceptable to us and the protein content of the weed is satisfactory then we may make a deal with Australia. "

He said that he was taking some samples of Australian kelp back to Manila for laboratory analysis.

Grows in plenty.

An expert of the Fisheries Division of the Commonwealth Scientific and Industrial Research Organisation said that the kelp weed grew prolifically off the coast of Tasmania.

C.S.I.R.O. scientists had been engaged in research into this weed, he added. The scientists maintained that fishermen could harvest big crops of the weed fairly easily near Tasmania.

Crops would yield many thousands of tons of dry weed each year. The expert added that if the Philippines adopted their proposal it would mean a new venture for Australia in international trade.

The seaweed would be a novel dollar-earner for Australia, he added.

A NOTE

ON THE ECONOMIC IMPORTANCE OF PHYLLANTHUS EMBLICA

By S.B. Das, B.Sc. (Hons.), A.I.F.C.
Assistant Conservator of Forests, Orissa.

Name :—Scientific—*Phyllanthus emblica*, Linn. Syn. *Emblica officinalis*, Gaertn.; *Cicca emblica*, Kurtz. Vernacular—Hindi : *aonla, amla, amliki*; Punjabi : *amli*; Marathi : *avala*; Bengalee : *amla*; Assamese : *amluki*; Oriya : *aonla*; Tamil; *nelli*; Telugu : *userki*. The most popular and commercial name is *amla*.

Distribution :—Common in the mixed deciduous forests throughout the greater part of India. It is a well known plant commonly grown in the village gardens.

Phyllanthus emblica, the '*amla*' is a common garden plant grown in most parts of India for its fruit. The importance of this plant has been known from ancient times, specially as a source of indigenous medicine and food. The knowledge of the great medicinal properties and the food value of the fruit has been imparted from generation to generation. In olden days, it was considered a hereditary and sacred duty to grow a few *amla* trees in the homestead or village common land. Constant association with the plant for its utilisation led to the tree being held in great veneration. While the growing of the plant was considered sacred, its destruction was held sinful. There are various references to this plant in Hindu rituals. The Ayurvedic literature is full of praise for the medicinal properties of the bark, leaf and fruits. Modern science, besides confirming these properties, has found in its fruit one of the richest natural sources of vitamin C which is an essential part of our diet. Lack of vitamin C causes scurvy, a common disease among ill-fed people during famine.

Medicinal value :—*Amla* has very great reputation in the indigenous system of medicine which is adopted even to-day by about nine-tenth of the population of India inspite of the popularisation of the western system of medicine. With the researches conducted by the Tropical School of Medicine, the pharmacopoeial properties of this plant will be brought to light very soon. The parts of the plant used in indigenous medicine are the bark, leaf and fruit, all of which are otherwise harmless to the human system, if taken in.

Bark :—The root bark after being powdered with turmeric is well ground and taken daily in a dose of about one tola by weight in serious cases of gonorrhoea. Continuous use for about a week gives good results in curing the disease. The decoction of the bark is also used to wash wounds and boils as an antiseptic and also to cure them. Blood dysentery can be effectively cured by the oral administration of the decoction.

Leaf :—A decoction of the leaf and bark is highly efficacious in diarrhoea. The leaf or its powder is used to render muddy water clear and pure.

Fruit :—The fruit forms the base of invaluable drugs. It is the embellic myrabolan of commerce and is an essential component of the medicinal mixture '*triphala*' (drug of three fruits) which is indispensable in the Ayurvedic system of treatment. Very great virtues are associated with the fruit. It is said that eating one or two raw fruits or a little quantity of the dried pulp daily destroys all the diseases arising out of phlegm, wind and bile which are considered to be the sources of all the diseases of the human system. It is on account of these properties, that the use of the pulp of the fruit (commonly known as *amla*) on the head and body and as food and medicine were almost made compulsory, under the laws of health of ancient India so much so that all religious and festive occasions were performed by smearing *amla* over the head and body together with turmeric which is another health promoting agent. The use of *amla* in a tropical country like India is particularly helpful as a cooling agent and has been well advised.

The ripe fruit has mixed properties of being sweet, astringent, acidic, bitter, emollient and cooling. It is restorative, expectorant, laxative, antibilious, carminative, diuretic, blood-purifier and a general tonic. It increases vitality, prolongs longevity, prevents premature disability and increases powers of memory. In leucorrhoea and haemetemesis of females, oral taking of the decoction of *amla* is very useful. The dried pulp when taken with '*lohabhasma*' (the active principle of iron) cures jaundice, dyspepsia and prevents loss of blood. A dilute solution of the cold extract of the pulp in water is said to render the eye-sight clear and the eyes cool if used in drops over the

eye for some days. Application of *amla* to the head by rubbing specially early in the morning promotes growth of hair, prevents baldness and, renders the hair smooth, soft and deep black. Diabetes and unconscious passing of urine in bed (ureclipsia) can be cured successfully by eating a mixture of *amla* powder and honey continuously for several days. The difficulties and pain occurring while passing urine can be removed by the oral administration of large quantities of *amla* extract and by the application of a paste of the pulp on the abdomen. The fruit pulp is used in all forms of gonorrhoea. In the case of gonorrhoea attended with exudation of pus and inflamation in the urethra, it is advisable to drink *amla* extract and douche the urethra with a boiled and cooled decoction of *amla*; thereby the formation of pus is arrested, the inflamation is soothed and the wound is gradually healed up. In spermaterrhoea, *amla* powder is taken in warm fresh cow's milk for some days till the system is cooled thereby stopping the unconscious discharge of semen. Its properties as an expectorant are utilised in cough and hicup: *Amla* powder boiled with milk and ghee added to it forms a good medicine for cough. In hiccup, great relief to the patient can be rendered by the oral use of mixture of *amla*, pulp of the ripe fruit of *Feronia elephantum* and *vasak* in honey. It is a general tonic and a good blood purifier. It promotes the brightness and beauty of the body when applied daily over the body and on the head in a mixture with oil of sesamum. It is also helpful in various skin diseases arising out of impure blood and excess of bile *e.g.*, eruptions, psoreasis and leprosy, if its powder is eaten for a long time and the body is washed with its concentrated decoction. Boils and wounds on the head are cured by the application of *amla* powder, sugar and as an ointment. *Amla* extract boiled with pure ghee to thick consistency is applied in gout. *Amla* powder in cow's urine is applied as an ointment in scabies and itches of children. Excessive sweating from the hands and feet can be prevented by eating *amla* powder and by the simultaneous washing of hands and feet with a decoction of *amla* about ten to fifteen times daily. Remission of erysipelas fever takes place if an extract of *amla* is taken with ghee. In the case of piles, a paste of the powder is spread on a small earthen plate and some curd is placed on it for some days and this curd is applied to the piles. Patients suffering from urticaria are made to swallow some *amla* extract in fermented *gurh*. Rheumatic and other vomitting, and nausea can be cured by a mixture of sandal wood paste in *amla* extract. Serious cases of exudation of blood from the nose due to the overheating of the system can be cured by the application of the ground pulp fried with ghee on the head. Acute bacillary dysentery can be arrested by drinking a *sherbet* of *amla* and lemon juice together.

Amla oil: The pulp contains an oil which is an essential constituent of many hair oils of commerce and the medicated amla-oil sold in the market is prepared out of it. Amla-oil has the property of promoting the growth, softness and blackness of the hair and of keeping the head cool. It is on account of this oil that the pulp is rubbed on the head.

Food Value:—The fruit of *Phyllanthus emblica* has very great food value. It has been found by chemical analysis that it is very rich in vitamin C, containing as much as twenty times the quantity present in orange juice. A single *amla* fruit is equivalent to nearly two oranges in respect of the content of vitamin C. Owing to the abundance of the trees in the forests and in the gardens and the huge quantities of fruit yielded by the plants, it is considered that this tree is one of the richest natural sources of vitamin C. Supply of vitamin C to the people from artificial sources, mostly in the form of patented medicines, is naturally very costly and limited. Modern scientists have, therefore, attached very great importance to *amla* fruit. Our ancestors used these fruits both as medicine and food extensively almost in every household in the locality where it grows, and they were fully aware of its energy giving properties although they might not have known that it contains vitamin C, which is the essence responsible for the energy.

Amla fruit does not lose its vitamin C content even on heating or drying due to the presence of a strong acid juice in it. The food value can be retained in it when preserved for some time by drying the pulp or salting it. The fruit is minced into small pieces and dried in the sun and preserved free from dampness. The salting is done in the following manner:—Big and healthy ripe fruits are collected, washed and then crushed. The stones are removed and the pulp is taken in an earthen pot and sufficient salt is added to it. The pot is then kept in the sun continuously for several days till the acidic extract gets partially or wholly dry. The salted pulp is then preserved in glass jars free from dampness. The entire fruit can also be salted and preserved. Similarly, pickles, jams and jelly can be prepared and preserved.

Tannin:—The fruit contains gallic acid and yields tannin somewhat inferior to that of the chebulic myrabolam. The bark of the twig

and the leaves also yield tanning material which are of only local use.

Fodder :—The tree is reported to be lopped for fodder in some parts.

Major Forest Produce—Wood :—The wood is used in the construction of houses and for agricultural implements specially where the choice of timber is limited. Use of the wood as timber is restricted due to its bad qualities of warping and splitting inspite of its being hard and close-grained. It forms very good fire-wood and charcoal.

Arbor tree :—It has been planted as a garden tree from very old times. On account of its light, feathery foliage casting light shade, it is suitable for growing in gardens. It is also beautiful to look at.

Thus the economic importance of the tree is almost entirely attributed to the minor forest products which, although classed as minor produce in comparison with major produce like timber and firewood, are really not so unimportant when their money value and special values as food and medicine are taken into consideration. The plant should, therefore, be considered as an important tree which should be encouraged in every possible way. It grows abundantly in most deciduous forests. At present, the minor produce from it is not being properly exploited. Large quantities of the produce are being collected by individuals from the forests but this does not attract the attention of the average forest officer. Hence, if properly exploited and put to use, the produce will yield revenue much more than what is being obtained. Collection of fruits from the forests is inevitably costlier than from the village gardens. Further, there are many localities without forest. The cultivation of the plant should therefore be extended. It is a good tree for growing on all village common land and farms.

Artificial regeneration :—The flowers appear from March to May; the fruits ripen from November to February. The seeds can be extracted by drying the fruits in the sun and letting it dehisce. The plant is comparatively hardy and easy to cultivate. It is commonly grown from seed which is sown before the rains. No seed treatment is required. In nurseries, the seedlings will have to be kept weeded. They will be large enough to be planted up at the end of the rains. The technique of growing the plant is commonly known. There is an improved variety yielding larger fruits. It is popularly known as *Benarasi*. This is propagated by grafting, and is better suited for growing on the home-farm.

(In Dehra Dun seedlings have been raised by sowing the seed in the nursery about March, watering regularly and sparingly and protecting them from sun and rain. The seedlings are sensitive to transplanting. Direct sowing can also be done but regular weedings are necessary for success. Seeds should be sown liberally.—*Editor*).

NOTE ON SHEKHAWATI AFFORESTATION SCHEME.

(A scheme for the trial of different kinds of trees, shrubs and grasses in the semi-desert tract of Shekhawati, Rajasthan)

BY MAHENDRA PRAKASH, M.SC., B.SC. (FORESTERY), EDIN.

The desert of Rajasthan is spreading at the rapid rate of 300 sq. miles a year. Our better quality soil is being invaded and covered by the sand shifting with the West and North-West winds.

The Government of Jaipur State approached the Indian Council of Agricultural Research with a scheme to prevent the encroachment of desert conditions and to find out varieties of trees, shrubs and grasses which will be suitable for growing in this area. The I.C.A.R. sanctioned this scheme at a total cost of Rs. 48,000/- for three years, one half of the cost being borne by Jaipur State. The work had to be supervised by the Conservator of Forests, Jaipur.

AIMS AND OBJECTS OF THE SCHEME.

(1) To prevent the spreading of the desert caused by shifting sand.

(2) To find out suitable trees, shrubs and grasses that will form a cover for the ground and also increase the fodder supply.

(3) To find out by experimental work, the best method of propagation of such species.

(4) To find out a technique for the rapid multiplication of the already existing species whose utility has long been established.

(5) To establish an oasis in the desert by opening a central nursery for supplying plants and rendering advice to the inhabitants of Shekhawati, who are by nature great tree-lovers.

PLACE OF WORK

After an extensive search for land to start the Experimental Station only about 113 *bighas* of land have been promised in Jhunjhunu, the acquisition proceedings of which are still in progress. However, two small nurseries at two places near Shunjhunu railway station and the secretariat building respectively have been started in April 1949.

WORK DONE

After obtaining technical advice from the Forest Research Institute, Dehra Dun and the Systematic Botanist to the Govt. of Madras, seeds of various kinds of trees and grasses have been sown in the nursery. Plants which may be suitable for the dry areas have also been brought from the Govt. nursery, Delhi for trying in this locality.

The following kinds of trees are being tried :—

1. *Prosopis juliflora* (विलायती खेजड़ा)
2. *Albizzia lebbek* (सिरस)
3. *Holoptelea integrifolia* (छिलल)
4. *Tecoma undulata* (रोहेड़ा)
5. *Prosopis spicigera* (देशी खेजड़ा)
6. *Acacia arabica* (बबूल)
7. *Azadirachta indica* (नीम)
8. *Dalbergia sissoo* (शिशम)
9. *Pongamia glabra* (करंज)

A large number of very quick growing trees, locally known as *arru* which have been raised in the nursery at Jaipur, will also be introduced in Shekhawati. Its leaves are a very good fodder for goats because it is said to increase the yield of milk. The bark of this tree has medicinal value.

Seeds of six kinds of grasses were obtained from the Systematic Botanist to the Govt. of Madras and tried in the nursery, out of which one (*Panicum antidotale*), succeeded well.

Seeds of *anjan* grass, guinea grass and *doob* have been obtained and will be tried in the rainy season.

A grass commonly known as *sewan* grass, tall and fleshy and very nourishing for the cattle, which is reported to be common in parts of Jodhpur and Bikaner, is being obtained for trying in this area.

UTILITY AND IMPORTANCE OF TREES AND SHRUBS INDIGENOUS IN THE LOCALITY.

There are many kinds of trees which have a great utility in Shekhawati. Among them are:

1. *Prosopis spicigera* (देशी खेजड़ा). A most useful and much loved tree of cultivated lands. Field crops grow well under the shade of this tree. Its leaves and branches are lopped for fodder. The fruit provides good fodder for camels, sheep and goats and is also used as vegetable by the people.

2. *Tecoma undulata* (रोहेड़ा). The wood of this tree was extensively used for beams in house building. Beams of the size 12 feet long and over 6 square inches in cross-section and elegantly carved are still seen in many old buildings without any signs of decay. It is a pity that this tree is now rarely found and that too with crooked boles and of small sizes, about a foot in diameter. Straight and good sized trees of this kind have to be grown.

3 *Nim* (*Azadirachta indica*), *siris* (*Albizzia lebbek*) and *ber* (*Zizyphus jujuba*) do very well in this area and have to be encouraged through the supply of seedlings to the local population.

A shrub commonly known as *phog* (*Calligomum polygonoides*) grows very well on pure sand and is useful as a sand binder. It also provides fodder for camels, and the fruit mixed with curds is eaten by man.

Kair (*Capparis aphylla*) is very popular in Shekhawati; its fruit is used in pickles and the young shoots provided fodder for camels.

Jaal (*Capparis horrida*) is another evergreen shrub which attains fair sizes and is very common in Shekhawati; so is *ak* (*Calotropis gigantea*).

Tarwar (*Cassia auriculata*) commonly known as *anwal* in Rajasthan, has also great scope. In two years its bark gives excellent tanning material. Seeds have been obtained for trying this species in Jhunjhunu.

FOREST MANAGEMENT

BY DR. K. KADAMBI

*(A general Survey)

Mankind lives only by virtue of our natural resources. Without the sun and rain and the continued productivity of the soil all animal life would be extinguished in a matter of days.

A forest is produced by these natural resources, through their continued interaction for decades, nay for a hundred or more years. We can *mine* these resources and thereby feast for a short time and with a minimum of effort, but *mining* is a process of *liquidation*, and such feast is always followed by *famine.*

Forests are a *soil crop*, but the crop rotation, instead of being seasonal like the agricultural crop, stretches over a period of probably a hundred years. Improvement or deterioration is slow, and man is impatient, but identically the same principles apply to both types of crops.

Nature, left undisturbed, will maintain some suitable crop on the soil and constantly build up the productive capacity of the soil. When man begins to harvest, and profit, by these accumulated natural resources, he invariably upsets the natural balance often seeking to remove more than nature is able to produce; in so doing he eats into his capital; he is treating the resource as a *mine* instead of a *renewable crop.* By intelligent use, man usually can improve on nature's efforts, but this takes knowledge, care, and foresight. Without these that is to say, without intelligent *Management*—the resource is always destroyed.

Whether we are handling a farm holding or a forest estate, good management or mismanagement produce identical results in the end, in terms of profits or poverty.

Forests have been like cinderella among the natural resources of our Country, and Forestry—unlike agriculture—has not been well understood or appreciated. Now, however, this is rapidly changing. The great economic value of our forests is being more fully recognized. The demand for practical knowledge of forestry has become greater than its supply.

Wood serves a number of man's needs and its new uses have been growing daily, while the accessible supply has been diminishing. This increases the prospects of benefits which sound forestry practice can give to forest owners.

The knowledge of proper management of forests concerns not only the professional forester, to whom has been entrusted the large forest property of the State, but it concerns the members of every branch of our administrative services.

Nay, it concerns every one, as a forest truly is everybody's benefactor. Wood is used for our needs daily, in many forms but the forest also benefits us all in many other ways. Forests are needed for the conservation of water supply in the soil and control of the flow of streams, to reduce or avert the danger of floods and droughts, for protection of the soil from erosion, for fish and game protection, for good influence upon adjacent crops, and for other vital needs, such as wholesome out-door recreation.

Too often, to their sorrow, people have not appreciated this until too late.

Those who, however, unwittingly, abuse or destroy forests often penalise themselves. They always *cheat* the next generation of its rightful heritage. Entire communities are apt to suffer.

Public spirited leaders—such as political representatives, clergy and particularly, members of the permanent administrative services, whose ranks you gentlemen are shortly destined to fill, and teachers—would do a great service by giving their support to the spread and use of sound forestry knowledge. When the help of a trained forester is not obtainable, they may make direct arrangements for elementary instruction to groups of boys or grown-ups, using the contents of simple booklets on forestry. Unfortunately, I am at present unable to recommend a suitable booklet detailing our forestry conditions, but we hope to produce one shortly in English, and to have it translated to every important local language.

***Lecture delivered by Dr. K. Kadambi, Asst. Silviculturist F.R.I., to the Probationers of the Indian Administrative Service.**

1. Development of Forestry in Historical Times

Starting with the eastern Mediterranean countries two or three thousand years before Chandragupta Maurya the treatment meted out to forests has followed the same general pattern in every civilized country.

First, an overabundance of timber; that is to say more timber than the generation of the day could use.

Second, an expanding use of wood, and development of a profitable wood business, accompanied by extravagant use and outright waste.

Third, a gradual realisation of the value of the crop and an uneasy feeling that something ought to be done about it—somebody ought to pass a law.

Unfortunately, at this stage the *disease* has usually developed to such proportions that a *law* will not arrest its progress.

Generally speaking, the practice of forestry is, perhaps, the most altruistic business in the world. Speaking in large, round generalities, it takes 100 years to grow a tree. People do not live 100 years. To keep forests productive, the logger must—either by planting or modified timber cutting and, in any event, at some appreciable trouble and expense—provide for each succeeding crop. Human nature simply refuses, consistently, and at daily measurable expense—to provide for the livelihood and welfare of Posterity. Hence, good forest practice has never been attained, except through more or less rigid regulation imposed by the State.

Retracing our steps to our outline of forest history, to note a few supporting examples, among the very early records, we find that Hiram of Lebanon gave king Solomon of Israel ceder and fir rees as much as he wished to have from his forests. King Solomon sent 30,000 men to fell and remove the wood. The forests of Lebanon have, for centuries past, been only a memory.

Greece, Italy and Palestine, originally well wooded, followed the same course. Italy began to feel the pinch of wood scarcely about 200 B. C. Spanish forests suffered their first serious depletion at the hands of prospectors looking for silver about 100 B.C.

This is going a long way back into history, but it is instructive. Apparently, once a nation has finally destroyed its forests, it rarely has the hardihood of Character to struggle through 100 years of rehabilitation. Erosion and other attendant evils of deforestation weaken the economy, and the possibilities, instead of improving, get progressively more hopeless.

While all this was going on in the so-called cradle of civilization—the Mediterranean Basin,—central and north Europe were still in possestion of primitive tribes, but as *culture* and population moved north the story was repeated.

By the end of the eighteenth century, forest devastation had gone so far in Europe that concern for the future of the wood supply, to the point of panic in some cases, induced drastic measures of conservation. In various localities, various restrictions were adopted. Wooden houses were forbidden. Fire ordinances were enacted. Clearing for settlement was restricted or forbidden. Wooden fences were supplanted by hedges and stone. Turf and coal were substituted for fuel wood. Even the use of wood for coffins was forbidden!

There is a stage at which, with a sufficient remnant of forest left to tide over the difficult days of rehabilitation, a forest estate can be brought back to full production without too great immediate hardship. Central and northern Europe chose to rehabilitate. These countries, under long course of sustained-yield management, are now timber-exporting countries and there is more than a casual relationship between forest policies and the fact that, apart from current war debility which too has already been overcome, these are amongst the wealthy, progressive nations of the world.

In India, sylvan laws existed for a long time, say since the advent of the Mughals in the north and the rise of the Vijayanagar dynasty of kings in Deccan, but most laws aimed at the conservation of game in certain extensive forest territories where the ruling monarch resorted to the favourite sport of Royalty from times immemorial, namely Shikar. Even in our semi-historical epics we hear of kings going out with bow and arrow to rid the people of the havoc caused by wild animals. We are also told of such expeditions against the offensive beasts of our forests in the days of Shri Harsha. About the middle of the eighteenth century the earliest measures at

the conservation of certain special kinds of forest trees began in India—Sandal-wood—(*Shi-Gandha*)—the famous wood whose aromatic oil has practically no satisfactory rival even today over the whole world, was declared a " Royal Tree " by the rulers of Vijayanagar and their vassals. The rulers of Mysore, in fact, set up an efficient organization for the extraction of the tree, separation of its heart-wood, classification according to variations in its quality and sale. Eighteen quality classes of wood were distinguished, each with well defined characteristics according to which the wood was carefully assorted in the sandal depots and sold under a well organized system. That versatile timber of India and Burma, Teak, was also declared a ' Protected tree' by the end of the 18th century by some southern Indian monarchs. The English, too, lost no time in casting their eyes on the resources of our Indian forests, soon after they come to power. After the rape of Burma was accomplished they declared Teak a Royal tree about the forties of the last century. Lord Dalhousie, that efficient British Governor General, was the first to enact about the year 1860, what is called " *The charter of Indian Forests* " which laid the foundation of regular forest conservancy in British India. This was followed in about two decades time by the first " Indian Forest Act " of 1878, which vested in the Government the authority to create " *State forests* " or "*Reserves* ". The first systematic step in "*forest management* " under the British Rule was thus taken about the middle of the last century, and as that century wore on large forest areas had already been nationalized and given the requisite protection against unsystematic exploitation and abuse.

What is Forest Management ? This has been variously defined, but apart from all conventional definitions, with which it is not my intention to worry you, Forest Management in its comprehensive application means " Forestry ". Applied "Forest Management" is the planned, orderly and conservative use of the Forest Resource whether it be the farmer's wood-lot of 10 acres or the Indian Republic's forest domain of some 171,000 square miles—as opposed to Forest Liquidation. In simple words, Forestry or Forest Management, means continuously efficient handling and use of the forest. It means full use of the capacity of the soil to grow trees, or to produce wood for the needs of the people.

A mine is worked until exhausted—then abandoned. Farm crops are sown, reaped, then sown again. The forest should not be treated like a mine or a form crop. It should always be kept a going concern and handled rather like a large herd of cattle which keeps breeding and going all the time so that, the younger stock, without loss of time, fully replaces mature animals that are sold or killed for use.

Many insufficiently informed people think of forestry only as planting of trees and protection of forest from fire.

They are not entirely correct. Planting is not necessarily a part of sound forest management ; as a rule it may be needed only where forest management has not been quite sound, or to establish artificially a forest or a new kind of tree where it did not previously exist.

Stripping forest land of all trees and then planting young trees is often not commercially practicable, as planting represents a considerable investment, the returns of which can be obtained only after many years of waiting. Such practice usually would be as extravagant as that of the owner of a herd of cattle who, without necessity, disposes of all his cattle at once regardless of their age or selling value, and starts the herd over from scratch by buying hundreds of *young calves.*

Trees take much longer to grow than cattle.

Forestry should normally depend upon nature for the replacement of the trees that are cut, through the use of cutting methods which result in prompt and good restocking with desirable kinds of trees. Such cutting is usually partial or " Selective " so that only the trees that justify cutting at the time are taken and those that are left standing can increase their growth because of the lessened competition.

One does not necessarily have to wait years for returns from forestry. It should begin to pay promptly and should pay always.

The Forest is a soil crop. Each acre of forest soil is capable of growing just so many cubic feet of wood each year. How much the forest-acre will grow depends on a number of factors over which we have little or no control, such as temperature, rainfall, hours of sunshine, and soil quality.

By apt forest management we can induce the forest acre to produce an annual crop that closely approaches its maximum capacity,

but there is a definite limit to that capacity. If we cut and carry away each year only as much as the forest is growing, we can continue to profit by this harvest, year after year, *and for ever*. If we cut more than the forest is growing we draw on capital accumulation and eventually must come to the end of our resources.

2. Sustained yield.

Forest management may be likened to the businessman's bank account. So long as the businessman withdraws (cuts) from his account (forest) a little less than he deposits, his accumulated savings do meet exceptional expenses, such as expension of his plant or to replace outmoded machinery (to cover fire losses or to take advantage of a good market), but as soon as his average withdrawals persistently exceed his average deposits, his business is insolvent. For all such, the creditor (money lender) is always waiting just round the cover.

Forest management therefore seeks to:—

(1) Keep every forest acre under growing forest crop.

(2) Protect the growing and mature timber from insects, disease and fire.

(3) Confine the average annual harvest of wood to not more than the average annual growth of wood.

(4) Constantly increase the quality and quantity of the annual harvest by a judicious selection of the timber currently to be cut.

Such a programme, rigidly adhered to, will ensure a steady income through a raw-wood supply for a stable forest economy (or forest industry) producing maximum employment, wealth and benefit for the community at large.

To cut and harvest less than our forest lands are producing is to sacrifice wealth at hand. To cut more than our lands are producing is to walk, wide-eyed and conscious, of deliberate choice, into bankruptcy.

Sustained yield means that the forest growth should balance the losses in wood volume due to cutting and decay of the whole forest, over a period of time.

3. Working Plan.

To carry out forest management efficiently we prepare what are called "Working Plans,"—a working plan is, in short, *an instrument of forest management*. It is drawn up in accordance with accepted rules, by a trained forest officer, and its application to the forest is sanctioned by the Government. It ensures continuity of policy which is a very important advantage, especially in state forests where the officers in charge are liable to be transferred frequently. It serves to lift the mangement above the vagaries of individual officers in charge. It systematises the control of the management. It regulates the yield on the principle of the sustained yield.

4. Increment.

When trees have all that they need, young trees grow fast in height as if trying to avoid being overshadowed and suppressed. Only when fairly tall do they begin to increase rapidly in thickness, and they normally make the best volume growth in their middle age. Increment is this increase in growth in height, thickness, volume, etc. It is determined for any given period by measuring the height, diameter or volume at the beginning and end of the period. The "*mean annual increment*" at any given year, is thus the average of past production. The date of culmination of the mean annual increment is of considerable significance in forest management, for it represents the age at which the annual volume production of the crop has shown a steady increase, and after which the crop shows a steady fall in production. The relation between volume of timber standing in a crop and the increment (growth) is expressed by "*Increment per cent*".

It corresponds roughly to the rate of interest on money deposited in a bank.

When cut, various trees show what are called *annual rings of growth*, on their stumps. Each ring normally represents one year's growth. The width of these rings clearly shows how fast or how slowly the tree was growing at any time in its life. The rate of growth of a tree can be calculated by a study of the growth rings. The yield from a forest is regulated after study of the rate of growth of the trees composing it.

The Working Plan will tell us :—

(1) How much wood and of what kind there is in the forest.

(2) The products for which the wood is best adapted—and for which it can be grown most profitably under local conditions.

Typical Sal (*Shorea robusta*) forest worked under the Selection System.

(3) How much wood can be cut from the forest without risk of exhausting it, or encouraging weed species.

(4) What method of cutting should be used for best results—as regards convenience of extraction, satisfaction of the market and replacement of the wood cut by regeneration, natural or otherwise.—This leads us on to what is known as "*Silvicultural System*"

5. Silvicultural Systems.

By *Silvicultural System* we understand the method by which a forest crop is cut and replaced. It should satisfy the following :—

(1) Provide wood for the present needs.

(2) Permit efficient and economical logging.

(3) Have good effect on the growth of the desirable trees

(4) Assure good and prompt restocking with desirable species (and discourage weeds).

The silvicultural systems commonly practised in India are :—

(1) **Simple Coppice System.—** This is suitable for forest from which we cut firewood and wood of small sizes. It can be applied to small forest holdings, especially to the farmers wood-lot. Here all the forest trees are cut in one operation and regrowth is ensured by the coppice shoots which emerge from the cut stumps. It can, therefore, be applied only to forests where the tree species possess coppicing power. Coniferous forests do not normally coppice and this method can therefore be only applied to forests containing broad-leaved tree species.

(2) **Coppice with Standards.—** In this method, instead of the whole crop being cut, a few trees are left standing—say 30 to 60 per acre—and the rest are removed. Regeneration takes place both by coppice shoots and by young seedlings growing out of the seed cast by the trees left standing (standards). This method is specially useful for small or moderately large holdings, such as village or communal forests, where the forests have to satisfy the needs of the community for both building-timber and firewood.

(3) **Selection System.—** Under this system individual trees are selected and felled when they reach a certain size which is carefully fixed after studying the crop. This size is known as "*Exploitable Size*". Several important teak forests of Southern India and some deodar forests of the Himalayas are worked by this system. Regeneration takes place generally by the natural method, in which the existing trees cast seed and these germinate and replace the tree felled. Such forests generally yield building timber (*i.e.*, timber of larger sizes) only (Photograph).

For selection cutting each tree must be chosen intelligently, *with due regard to the present and the future*. Felling gaps are sometimes regenerated artificially by *Gap Regeneration*.

(4) **Uniform System.—**This method is extensively used for sal throughout Uttara Pradesh. It is the standard system for chir and the deodar forests of Jaunsar and Kulu, and the blue pine, spruce and fir forests of the Kulu division of East Punjab. In its typical form the fellings are divided under three main categories (*a*) The *preparatory* fellings (*b*) The *seed* fellings (*c*) The *final* fellings. The first series of fellings prepare the crop for natural regeneration by causing small breaks in the canopy and allowing sunlight to reach the soil. The seed fellings encourage seed production by causing further openings in the canopy and freeing the crowns so that they may seed in profusion. The final fellings remove the remaining trees after the natural regeneration is completed.

(5) **Clearfelling method and the Taungya system.—** Another system, and one which is a very important contribution India has made to scientific forest management, is what is known as the "*Taungya System*," or "Agri-Forestry". Here the old forest crop is clearfelled, the stumps extracted and the debris, after removing all useful material, is burnt and our agricultural crop is introduced along with a forest crop, after ploughing up the soil repeatedly. The forest crop is either sown or planted in lines 12 to 20 ft. or more apart and in-between its lines the agricultural crop is sown. One, two or more agricultural crops may be taken out of the soil before the forest crop is left to develop by itself. This method is becoming increasingly popular all over India and has been widely employed in Uttar Pradesh for raising forest crops of *sissoo*, *khair*, sal, *sain*, *bakain*, bamboo, etc. at Saharanpur and Gorakhpur and in Nilambur and Wynaad (Madras) for forming teak plantations at low cost to the Government and to the mutual advantage of the Government and the cultivator. The method is capable of very wide applicability all over India for the afforestation

all waste lands which could be set apart for the purpose of growing wood-lots.

(6) **Farm Forestry.**—The greater portion of India has inadequate forest area to meet the needs of the population for fodder, timber and firewood. We find waste land in every village which could be made to serve a very useful purpose in the economy of the country in supplying the requisite forest produce to the villages communities if we grow useful trees on them. Tree lines could also be created on the numerous intercultivation ridges; indeed a couple of light crowned, deep rooted trees like *babul* (*Acacia arabica*) could be grown with great advantage over every acre of land in our farms without any perceptible fall in farm yields. The *Taungya* system could play a very useful role in farm forestry all over the country.

Gentlemen, if, during administrative careers you are called upon to practice your knowledge of forestry, you can safely turn to the *Taungya system* to ensure adequate chances of success in your attempts.

6. The Rotation

Rotation has been defined as the period which lapses between the formation of a wood and the time when it is finally cut over. Under the clearfelling system it may be a precisely defined period. Under the other systems it represents only the average felling age of the stands. Various types of rotation are recognised, according to the objects of the management to which effect has to be given. Among them are (1) *physical rotation* which coincides with the natural lease of life of the trees (2) *Silvicultural rotation* which is the rotation most favourable for natural reproduction of crops (3) *Technical rotation* which is the time required for producing the maximum of material suitable for a certain purpose and of a given size such as railway sleepers, mine props, electric transmission poles, etc. There are also rotations of maximum volume production, highest yield, etc.

The Rotation period may vary from 15 to 20 years in the case of firewood crops, to 100 years or more for high forest which produces arge size logs.

7. Regulation of the yield.

The method of yield regulation may be broadly classified under the following heads:—

(A) Yield by fixed area or by area under a definite period.

(B) Yield by volume.

(i) **Area yield.**—This is useful for copice forests and to high forests which are clearfelled and artificially regenerated. If we have a forest area of say 400 acres to be worked on a 20-year rotation the annual area yield is 20 acres. In the case of area allotment by periods, the felling areas are not permanently fixed on the ground in the order of felling, but instead, portions of the area may be allotted to the various periods of the rotation. For example, the rotation for a sal forest worked by the Uniform method may be 90 years. This may be divided into 3 periods of 30 years each and a definite area (Periodic Block) allotted to each of the three periods. The annual yield for the first periodic block is obtained by the formula*

$$Y = \frac{V + \frac{Pi}{2}}{P}$$

Where Y. is the annual yield, P is the period, V. the standing volume in Periodic Block I and 'i' is the annual increment of Periodic Block I.

(ii) **Yield Regulation on the basis of volume.**—*These methods are often known as "Formula methods." They often lead to inaccuracies because they are based on the "volume" and "increment" calculations of a whole forest which are abstract qualities, and little or no attention is paid to the distribution of the age classes and the condition of the crop. Their use is justified provided the yield, as calculated by them, is not followed blindly, but is modified as necessary to suit the actual conditions of the crop, and provided frequent revisions of the working plan are made at which the yield is recalculated, on the basis of acutal remeasurements of the growing stock. The regulation of yield on the basis of volume has been classified as follows:—

Main basis	Secondary basis	Name of formula used for calculating the yield
(1)	(2)	(3)
Volume	(*a*) Growing stock.	Von Mantel
	(*b*) Increment and Growing stock.	Austrian method.
	(*c*) Size classes and periods	French method of 1883.
	(*d*) Tree as unit	Brandis method.

*From Lecture Notes 'Forest Management' by C.R. Ranganathan, Director, Indian Forest Ranger, College, pp. 33,41.

Formula
(4)
(*a*) Annual yield = Actual Volume of (Von Mantel) Growing Stock

$$\text{Annual yield (Von Mantel)} = \frac{\text{Actual Volume of Growing Stock}}{\frac{1}{2}\ \text{Rotation Period.}}$$

Apart from Von Mantel's formula which is easy to apply and also handy, Brandis method of yield regulation by volume based on tree as unit has been widely applied to the teak forests of Burma and South India. The rotation is divided into periods or felling cycles. The fellings go round the whole area of a fellings series once in each felling cycle and a calculated number of trees is removed from each coupe (annual felling area) which number is based more or less on the number of trees passing from the pre-exploitable to the exploitable size class.

8. Tending forest crops

Forest trees of the same kind, growing in the same soil and climate, and during the same time, will differ greatly in shape, size and volume—depending on the distance between their spacing.

Trees grown far apart typically have large branches, almost to the ground, their trunks are thick at the base, but taper rapidly and usually are of poor form, being generally full of irregularities. The value of such trees is low. On the other hand, if trees grow too close together, that also is bad. Because of overcrowding, such trees cannot get sufficient sunlight and enough water and minerals from the soil for good growth. They are very small and thin for their age. Instead of producing healthy wood, they fight one another. Trees growing with just the right "elbow room" between them are tall and large. Their trunks are of fine shape, straight, with little taper. For most of their length they are free of branches and a large part of their wood is quite clear of knots. Such trees are the best "money makers" for their owner. The forest operation by which we can help trees to grow with adequate "elbow room" is called "*Thinning*". Based on the intensity of this operation we classify thinnings into various grades, 'A' grade being the least intense and 'D' or 'E' among the most intense grades of thinnings. Our main object in carrying out thinnings is to provide healthy growth conditions and proper spacing between trees. It is the thinnings which enable us to reduce a forest tree crop with about a thousand or more plants in the beginning to the acre to about 40 at maturity.

When tree crops are younger, we have to *weed* them, just as we have to weed agricultural crops, and a little later the forest crops may have to be *cleaned*, *i.e.*, freed from their extraneous competitors. Bamboos, fast growing tree species and shrubs and climbers and twiners would soon-over power and destroy our forest crops unless timely cleaning and weedings are done. *Pruning* of branches may also have to be in some cases to produce high grade timber.

9. Forest Protection ; Enemies of Forest Crops.—The forest crop is exposed to various threats and dangers, whose list is rather long, but to mention a few important ones we have fire, grazing, wind, snow and frost, fungus, insects, water action and finally wild animals and lastly, *man himself*. Space does not permit of even mentioning the damages caused by each, but I must mention one or two which you gentlemen may be called upon to tackle during your administrative duties.

Fire is one of the worst enemies of our forests. A severe and uncontrolled fire may destroy a valuable forest outright in the space of a few hours. To localise and control fires, lines (cleared lines) are made through the forest at suitable intervals which are kept clear of all inflammable material so that fires may stop when they reach them. Fire wachers are appointed to patrol the forests and localise fires. Fire notices are put up at salient points warning persons not to start fires by negligent smoking or leaving open fires.

Grazing.—One of the worst enemies of natural regeneration in many of our forests is unrestricted grazing by animals, both domestic and wild. Domestic animals are most often the greatest offenders. To keep out grazing is impossible in many places as there are no alternative grazing grounds. Stall feeding and growing fodder tree species for the purpose are alternative methods and palliatives. But sometimes grazing is also advantageous.

One more, and that a very great source of danger to forest growth through the ages, has been man himself. The primitive tribes still carry on what we call *shifting cultivation*, by which we understand the clear-cutting of a piece of natural forest and burning the debris to obtain a fertile seed bed for agricultural crops. After taking out a couple of crops the scene of such cultivation shifts to a different patch of natural forest which is cut, burnt and destroyed in the same way. The ever increasing human population has made,

throughout the ages, more and more demands on the forests for agricultural land, and the ever-miltiplying cattle which follow man have added to the destruction by retarding the process of natural regeneration and rehabilitation of the forests cut down by man. The denudation of forests by man and their subsequent grazing by cattle result in land erosion of the worst kind, the like of which you will all witness whenever you visit any group of bare hills, or even of undulating land bereft of forest, which you may find scattered over the greater part of the plains of the sub-continent of India.

"Forests precede man, deserts follow him" is an old saying which is too true.

10. Forest Exploitation (Logging)

Logging is the harvesting of wood, and is usually done during various parts of the year, in different parts of India, according to local usages or custom. After felling trees are cut into logs or other required lengths, usually at the stump or at the assembling point near-by, or at the hauling road where the wood is brought by elephants or buffaloes or even by manual labour. The logs are skid directly over the ground. The bullock or buffalo-cart is still the favourite means of transport of all forest produce, but the use of motor trucks is increasing very rapidly. Where conditions permit river driving is used as a very cheap method of wood tansport.

Whether logging is done by the forest owner or his help, by contractors or by the purchaser of the wood, it should be done efficiently. Otherwise waste of effort and money on logging may greatly reduce the profits the forest is able to yield. Efficiency in logging comes not merely from experience and hard work but from soundness of planning, good technique, and good choice and condition of the equipment used. Proper care must be taken in logging not to damage the forest and not to damage good wood. Trees should be cut low, just above their rootswell. Well over 5% of good wood can be wasted in high stumps and a good deal of excessively large tops. In skidding and hauling when done from the stump, elephants and buffaloes etc. should be guided very carefully to avoid damage to young growth and, to make work easier, trees should be felled on open ground where possible so that they will not scar or break other trees.

11. Artificial Reforestation

Forest Planting requires considerable work and expense. Usually it is justified only where natural restocking cannot be used. In successful forest plantations trees grow very fast, form well shaped trunks and give large yields of wood per acre, mainly because of uniform, proper spacing between the trees and their full use of the ground. However, if planting is done badly, with poor stock or under unsuitable conditions, a plantation may fail completely. Trees may be planted to re-establish or establish a forest, to fill blanks that fail to regenerate, to introduce other species, to make wind-breaks or to stop soil erosion.

In deciding what species of trees to plant, their suitability for the purpose as well as the climate and the soil should be carefully considered. It is well to consult a local forest officer or to write giving full information about the project to the Provincial Silviculturist or to the Central Silviculturist, Dehra Dun. In general it is safest to choose the more valuable kinds of trees which are known to grow well locally, under similar conditions. If you want to grow building timber plant or grow teak or rosewood in the south of India, sal or sissoo in the plains of northern India and deodar or chir in the Himalayas. If you want a firewood species grow any of the various Acacias, Albizzias—*babul*, *khair*, etc. in the plains of the whole of India, casuarina or *sissoo* on sandy soils. If you want a fast growing exotic you may think of a suitable species of *Eucalyptus* of which there are over five hundred different kinds suitable for every kind of climate or soil found in India.

Planting 2 or even 3 kinds of trees may be practical if they fit together—if the slower growing kind can well withstand the shade produced by the faster growing species. Checker-board or strip planting of different species is better than the alternation of their rows.

Premonsoon or early monsoon planting is usually the best, from the time the summer draught is broken by the early S.W. monsoon showers in April or May until the first fury of the monsoon has spent itself in June or early July; the earlier the planting is done in the season the better.

Artificial regeneration can be broadly classified as follows:—

Artificial Regeneration

(i) Asexual means,

(a) planting { stem cuttings, branch cuttings, root cuttings, root sections.

(b) natural { root suckers, coppice shoots, stool shoots, pollard shoots.

(ii) Sexual means.

(a) by seed sowing—

(1) broadcast,
(2) in furrows,
(3) on patches,
(4) in trenches,
(5) on mounds,
(6) on ridges,
(7) on berms,
(8) notching germinating seed.

(b) by seedlings—

(1) stumps or
(2) entire plants
(a) in pits,
(b) in crow bar holes or stake holes.

While planting the plant roots might be naked or held in some container like a pot, brick, basket, pot-tile or a ball of earth.

Planting stock should be raised in a nursery, by sowing seeds in nursery beds suitably prepared. The standard size of a nursery bed is 40 ft. by 4 ft. Nursery raised seedlings are always better than wild seedlings (wildlings). A great many broad leaved species of trees can be *stump planted, i.e.*, seedlings can be made into what are known as "*stumps*" by cutting their shoot to a length of 1 or 2 inches and the root to about 8 to 10 inches before planting. Stumps are known to develop faster than entire plants during the early period of growth. "Premonsoon stump planting" is the standard practice for teak and various other species. The method is known to be suitable for '*sissoo*' also. For sal, sowing seeds is known to be the best, while for deodar and other conifers entire planting of seedlings kept in the nursery for a year or even two or three years may be advantageous. In southern and central India drought is the principal enemy of the planted stock, in the plains of northern India it is both draught (summer) and mild frost (winter) while in the Himalayas frost and snow are the principal enemies.

Planting distance.—To grow tall and not too branchy, the trees should be planted close enough, yet not too close as then they would compete and grow too slowly. A pacing of 6 ft. by 6 ft. is common practice, and with this spacing 1,210 plants will be required to plant one acre. In raising nursery stock an extra 20 per cent should always be allowed for replacement of casualties.

Cuttings.—Species of Ficus, willows and poplars can be grown best from cuttings of young, fast growing sprouts or branches. Ficus cuttings should be about 4 ft. or more long and as stout as a man's forearm. Cuttings of willows and poplars are usually from 3/8 to 3/4 of an inch thick and about 10 in. long. Each should carry at least one bud. Cuttings can be made and planted in spring or at the commencement of the S.W. monsoon. The cuttings are planted in holes or furrows. Setting them in a slightly inclined position makes it easier to firm the ground properly with the foot. Care should be taken to keep them from drying and not set them in upside-down position.

12. Conclusion

Gentlemen, we have given some attention to particulars of forest management. Now let us mentally stand back to see the whole picture.

Forest Management aims at the most profitable, continuous use of land for production of wood. It deals with growing, protecting and harvesting the forest. These three operations should be the well connected and adjusted parts of the process of efficient wood production. The use of the soil for tree growth should be as full and as uninterrupted as possible. *Growth, Protection* and *Harvest* of the forest are closely interrelated. Depending on how it is done,

logging (harvesting) can greatly facilitate or hinder forest restocking and the growth of the trees left standing. According to the method used, logging will also have a beneficial or bad effect upon protection of the forest. If protection is neglected and the wood lot is damaged by grazing animals, by fire or otherwise, forest growth, and the quality of the wood will suffer; logging will then be less productive and less profitable. The measures that promote good stocking, proper spacing and vigorous growth of trees help in protecting a forest from its natural enemies; they also lead to more profitable harvest in a shorter time. Destructive logging, through bad influence upon growth and upon protection of forest, robs the next harvest of its profits long in advance.

For efficiency the needs of forest growth, protection and logging should be dealt with in such a way that each of these three operations helps the others in serving their common aim—profitable, continuous production of the maximum of good wood.

It is obviously poor business to neglect the needs of forest growth and protection and to cut the forest so that it deteriorates and dwindles. It is a hard way to practise forestry if one has to use planting after cutting to obtain a new wood crop, and then only after many years of waiting. Normally, selective cutting is one of the best means of profitable wood-lot management. It is a sound way of harvesting wood, as it provides for cutting of trees that have matured, of those that need salvaging, and of trees that greatly hinder the growth of their betters. Properly conducted selective cutting is an effective means of forest protection, as it promotes growth of trees and makes the forest less susceptible to damage by its natural enemies.

Selective cutting serves at once the needs of wood harvest, of forest growth and of protection. It "*kills three birds with one stone*".

The main requirement for profitable management of a forest is intelligent understanding of its growth and life. Instead of trying to force nature through ignorance of its ways, one should know and guide its forces fully to serve his needs. The reactions of trees to man's influence often may be, or appear to be, rather slow but they are certain. The forest is very sensitive to the treatment it receives, and responds in kind.

Gentlemen, I do hope that what I have described to you during these minutes will help you to decide what you can do for our forests during your long administrative careers, to enable them to give their best to our Motherland. Try actually to do it. Good luck to you all.

THE OCCURRENCE OF *MYRSINE* IN THE INTERGLACIAL FLORA OF THE KASHMIR HIMALAYAS.*

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The School of Paleobotany at Lucknow during the last 25 years has provided abundant evidence to show that fossil plants are good indicators of past climates (Sahni, 1939, Puri, 1943; 1945a; 1946). With the advance in our knowledge of the edaphic relationships of modern plants it is becoming possible now to know something also of the soil conditions during the past ages (Puri 1949). This question is being specially examined with regard to the conifer flora of the Himalayas which is shown to be greatly related to the type of rock and soil (Puri, 1949, 1950) in the Kulu Himalayas. In the Kashmir valley, the chir pine community, which generally occupies quartzite or sandstone rocks in the outer Himalayas is conspicuously absent as none of the two rocks are found here. The main conifer community at lower altitudes is the blue pine on the Karewa clays, and at higher levels the silver fir community occurs on morainic deposits. The scarcity of deodar community in this region which is climatically well suited for its growth is due to the presence of the Karewas. This community has become prominent where the Punjab traps have come on the surface (Puri, *loc, cit.*). With the collection of further data we are extending such relationships to other forest communities as well.

The present note which describes fossil leaves of *Myrsine* is an attempt in that direction. The two species described here occur in oak forests of the N.W. Himalayas at the present time and it is interesting to see that they have been found from the fossil beds only at those localities where oak seemed to have been dominant in the forest vegetation of those times (Puri, 1945 b). The importance of the discovery of *Myrsine* in the fossil beds is thus two-fold. Firstly, this gives us another associate in the oak community and secondly it supports our ideas of the climatic and edaphic conditions of the valley during the Pleistocene.

Myrsine africana Linn.

(photos 1, 2).

A small leaf, figured in a natural size photograph 1 measures 1.05 in. long by 0.4 in. at the broadest part and has an obovate shape. The lamina gets narrowed into a cuneate base and has a broad apex with an acute tip. The margins are crenate from the middle, the basal part of the leaf being entire. The teeth are blunt and widely situated.

The venation is pinnate-reticulate with a faint tendency to become typically reticulate, as in leaves of *Berberis*. A fairly conspicuous midrib runs in the lamina thinning out towards the apex and gives off at acute angle 6-7 pairs of secondaries, which being thin are somewhat inconspicuous (photo 2) and run towards the margins giving off still finer branches in the lamina. Tertiary reticulation is in the form of small rectangular meshes. There is a finer reticulation consisting of a network of small meshes, which are seen in the leaf enlarged to five diameters in photograph 2.

Occurrence	.. Laredura at 6,500 ft.
Number of specimens.	.. Two only.
Type specimen	.. L.695.
Collectings	.. G.S. Puri, 1940.

The figured specimen is preserved in the Botany Museum, Khalsa College, Amritsar.

The fossil resembles with living leaves of *Myrsine africana* Linn. in shape, size, margins and all details of venation and is identified with it.

Distribution :—*Myrsine africana* Linn. grows in the outer Himalayas between the altitudes of 2,500 -5,500 ft. from north-east Afghanistan, Trans Indus, Salt range to Nepal. The altitudinal distribution of the species in different parts of the region may slightly vary from 2,000 to 9,000 ft. above sea level.

It is commonly met with in Baluchistan; the Kagan valley, Hazara at 4,800 ft.; and the Murree hills at 6,500 ft. It occurrs in Kashmir in the Tawi valley, Jammu at 3,000 ft; Keran; Kishtwar; Marwa Dachhan; Mirpur; Muzaffarabad; Ramban and Udhampur. Eastwards, it is recorded from Chamba at 4,000 ft.; Mundali Jaunsar; Bashahr state, Simla at 6,000-9,000 ft.; also the Glen; Giri

*Contribution from the Birbal Sahni, Institute of Paleobotany, Lucknow.

Road, Simla at 7,500 ft. It occurs in the Mussoorie hills between 6—7,000 ft. and is found at as low an elevation as 3,000 ft. It grows in the Garhwal division at 5—8,000 ft.; Naini Tal at 5,800 ft. West Almora, Kumaon division; and in Pokhari, Nepal. This small shrub is a common species of the temperate Himalayas forming low undergrowth in forests of *Quercus incana* Roxb. In the Murree hills it takes to shady places in the oak forests.

Myrsine semiserrata Wall.

(Figs. 3,4).

A single badly preserved leaf, which does not show much details of venation is ovate-lanceolate in shape, measuring 2.8 in. long by 0.7 in. at the broadest part. It gradually narrows upwards into a tapering apex and has a broad cordate base. The margins are broken but seem to be faintly serrate.

The venation is pinnate-reticulate and inconspicuous.

Occurrence	Liddarmarg at 10,600ft.
Number of specimens ..	One only.
Type specimen.	Loc. 34.70.
Collections	H. de Terra, 1932.

The specimen is preserved in the Botany Museum, University of Lucknow.

The fossil resembles leaves of *Myrsine semiserrata* Wall., in shape, size etc. and on account of the inconspicuous venation it is provisionally identified with this species.

Distribution:—*Myrsine semiserrata* Wall. grows in the outer Himalayas between the Beas and Bhutan at altitudes of 39,000 ft. It does not grow anywhere in the Murree hills or Hazara and seems to be extremely rare in the Kashmir Himalayas. Except for one sheet, No. 26752 in the Forest Herbarium, Dehra Dun recording the presence of the species from the chir pine forests between Batot and Ramban in the Chenab valley, Jammu at 3 to 6,000 ft. the species has not been collected from this region. Eastwards, it occurs at Dalhousie; Chamba at 7,000 ft. Jaunsar at 9,000 ft.; the Glen Simla at 6,000 ft; and is recorded from Jabberkhet; also Midlands; Landour and Dhobie ghat at Mussoorie. It occurs at Naini Tal; Haldwani division; East Almora at 4,000 ft.; Garhwal division, north range at 5--7,000 ft.; Landsdowne, Garhwal at 4,500 ft;: and in Tehri Garhwal.

CONCLUSIONS.

The fossils species of *Myrsine* are unrepresented in the modern vegetation of the Kashmir valley; however, they occur in oak forests of the adjoining areas at altitudes of 3,000-8,000 ft. Their presence in fossiliferous beds at altitudes of 6,000 ft. and 10,600 ft., along with remains of oaks and laurels, lends further support to the conclusions already expressed by the author (Puri, 1943, 1945b, 1946) that the altitude and climate of the Kashmir valley has considerably changed, since the Pleistocene times. These changes have also altered the edaphic factors and in place of the Punjab Traps the surface vegetation at the present time is affected by the overlying thick deposits of the Karewa Series, which being different from the former in chemical physical and biological properties allow the growth of a flora in which oaks, laurels and *Myrsine* do not feature. The absence of oaks and the scarcity of deodar in the modern vegetation of the Kashmir valley is partly due to changes in the soil that followed the glaciation in this area (Puri, *loc, cit.*). Thus, it may be concluded that fossil plants not only indicate the climatic conditions but also throw light on the conditions of the soil during the past ages, and in fact, if sufficient knowledge of the relationship of modern plant communities to their environment at the present time was available the science of paleoecology would have made useful contributions to geology and palaeontology.

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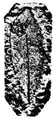

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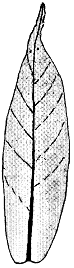

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[While appreciating the author's efforts at drawing out various threads of conclusion from the occurrence of fossil leaves, the Editor remains not fully convinced as to how the author has been able to decide that the incomplete and vague fossil impressions on which this study has been based belong to *Myrsine africana*, or even to the genus *Myrsine*. Every botanist knows how futile it is to base identifications on mere leaf specimens.]

FOREST AND PHOTOGRAPHY

BY P.C. MUKHERJEE

(Continued from June issue)

15. Enlarging.

This is a process for making bigger prints from small negatives on Bromide paper by means of projection with an apparatus known as an "Enlarger".

There are two kinds of enlargers in use,—one that is worked with daylight and the other by artificial light. This function of both is the same, *i.e.*, to project the image on a bigger scale on to the easel by means of a camera attached in front. The negative is placed behind the camera in a carrier and is illuminated from the back either by daylight or electric gas or oil burner light.

Negatives from which enlargements have to be made should be sharp in focus and of good gradations, *i.e.* neither too thin nor too dense. All pin holes should be removed and other defects rectified prior to enlarging.

Daylight Enlarger. It consists of a rectangular box made of either wood or metal having both ends open. One of the ends (called the "back") is projected outside the window shutter of the darkroom by cutting a hole in it. At this end of the box arrangements are made to hold the negative in position. For evenly illuminating the entire surface of the negative, a mirror or a white card, bigger than the box, is placed behind it at an angle of 45 degrees, which reflects the light from the sun through the negative. A camera, with its back removed, is attached in front of this box by means of suitable struts to project the image on to the easel. Focussing is done with the pinion or knob provided in the camera for the purpose. Southern light is best suited for working with a dalylight enlarger.

As the intensity of daylight changes with the varying position of the sun in the sky, strong and uniform illumination suitable for making enlargements can only be obtained for a couple of hours in the day at the most. Hence the number of enlargements produced per day with this class of enlargers is very limited. During cloudy days when no sun appears in the sky the enlarger has to be put aside as no work can be done with it due to insufficient light.

Procedure. The image is first sharply focussed on a piece of white paper which has been pinned to the surface of the easel board. The lens is then covered with a cap made of a ruby glass which allows the image to be seen on the easel while positioning the bromide paper but will not fog the latter. The exposure is made by uncapping the lens. Correct exposure is first ascertained by exposing one or two test strips and the full sheet of the bromide paper is then pinned to the easel and exposed. After exposure the paper is taken out of the easel and developed and fixed in the manner described under bromide printing.

For obtaining white borders in the print a suitable paper mask is placed over the bromide paper and the two pinned together to the easel. For quick insertion and removal of bromide papers while making a number of prints from one negative, the mask described below is most convenient to use and lasts longer.

Take a piece of thin strawboard which should be at least two to three inches larger on all sides than the paper to be used. Mark on its centre the exact size of the paper in pencil and draw inside it another rectangle A, $\frac{1}{2}''$ smaller on all sides as shown in the sketch. Next mark the areas 1, 2, 3, & 4 approximately to the shapes and sizes as shown in the illustration. (Fig 2). Now carefully cut out and

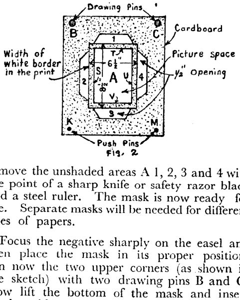


Fig. 2

remove the unshaded areas A 1, 2, 3 and 4 with the point of a sharp knife or safety razor blade and a steel ruler. The mask is now ready for use. Separate masks will be needed for different sizes of papers.

Focus the negative sharply on the easel and then place the mask in its proper position. Pin now the two upper corners (as shown in the sketch) with two drawing pins B and C. Now lift the bottom of the mask and insert the bromide paper so that all its sides sit flush

with the shaded sides S T U V, which can be seen to do so through the openings 1, 2, 3 and 4 made for the purpose in the mask. Pin now the bottom corners of the mask with two enlarging push pins K and M. The paper is now held in position by the mask and lies flat with the surface of the easel. The sides of the paper which are protected by the shaded sides of the mask S T U and V do not receive any exposure and so they remain white on development.

If wider white borders are required, the shaded sides S T U & V should be modified accordingly. These masks are suitable for both horizontal and vertical enlargers.

Enlarging by artificial light. This is done with an enlarger which is similar in principle to the magic lantern. The enlarger is illuminated either by electric light, lime-light, gas or oil, but the one that is worked with an electric light is indisputably the best of all.

It consists of a well ventilated lamp house which accommodates the illuminant in front of which is fitted a pair of optically ground condensers to ensure even illumination of the negative. The negative is placed in position in front of the condenser in a convenient holder and a camera is fitted in front of the negative with its back removed to allow the light to pass through the lens. In a modern enlarger the camera front is fitted with interchangeable lens pannel. In front of the lens a ruby glass cap is fitted in a swivel which can be swung aside during exposures.

These enlargers are constructed entirely of metal and are fitted on highly polished upright columns which are rigidly bolted to the base boards.

The exposure is made with the switch which is controlled either by hand or foot. The enlarger can be lowered or raised by means of a hand wheel for different sizes of pictures and the fine focussing of the image is done by a small bakelite wheel provided in the camera.

Shading in Enlarging. This is required to be done for printing the dense part of a landscape negative (such as the " Sky ") darker by shading the picture with a cardboard held in the operator's hand and moving it to and fro (between the lens and the picture) so that no sharp line of the shading appears in the print. A keen worker can thus do a great deal for improving his enlargements by various methods of shading which require very little skill. Local shading can be done by a tuft of cotton wool fastened to the end of a wire or by the tip of the operator's finger and also by making a small hole in the cardboard. For smaller enlargements (up to the quarter plate size) the Worker can use the palms of his both hands (which are free) for shading the parts of the picture required.

Diffusion in Enlarging. This method enables the worker to obtain effective results in his enlargements with the help of a clean piece of gass held between the lens and the picture and moving it up and down at an inclination while the exposure is being made. The farther it is from the paper the greater will be the diffusion and in this way softness in the picture can be secured at will. Also the thicker the glass the greater the diffusion obtained. Partial diffusion (known as " Soft-sharp " effect) of the image may also be obtained when enlarging by giving the first half of the exposure with the bare lens and the second half with the glass as explained above.

" Cellophane " used for wrapping cigarette packets may also be used for softening the picture during exposure by crinkling it in the hand and then smoothing it out again.

Another method is to make a separate lens cap and cut a circle in its middle, as big as the lens itself. On a piece of transparent film, from which the emulsion has been carefully removed, a series of fine circles less than $\frac{1}{8}$ inch apart) are made with the point of a draughtsman's divider. The film is then fastened over the aperture made in the cap with glue. First half of the exposure is made with the bare lens and the second half with the film cap over the lens.

The enlarged image should be sharply focussed on the easel before using any of the diffusion devices to soften the result.

It is quite a different softness from that got by leaving the picture out of focus and it hides pinholes and other slight blemishes on the negative. For this reason it is invaluable in making bigger enlargements from the miniature negatives without showing any perceptible grain in the prints. Although the method is so simple, it will be found that the effects obtained are in no way inferior to those produced by the most expensive " Screens ' or soft-focus lens.

It is to be noted that the use of a diffuson device necessitates a slight increase in the exposure and requires the use of the next grade of contrasty paper to preserve the brightness of the picture.

16. Forest Photography.

Photography inside the forest is a difficult subject which calls for greater skill and patience on the part of the photographer to secure his end, and a forest photographer has often to deviate from the general rule of exposures followed by landscape photographer for obvious reasons.

The photographer who is required to make exposures inside the forest for his particular subject faces in the first instance the difficulty of obtaining the proper light. In dense forest the light is often so poor that it becomes difficult for the photographer to focus sharply the view on the focussing screen. Closely situated trees with heavy foliage and dark foreground are classified under " Dark Subjects " and they, therefore, necessitate an increase of at least double the normal exposure to record them faithfully in the negative. For this reason it is always advisable to set the camera on a tripod and make the exposures with the wire release to guard against the risk of a camera shake.

The rule that the sun should be at the back of the photographer is often so slavishly followed that the resultant photographs often become uninteresting on account of insufficient light and shade in them. It should always be remembered that the harsh frontal lighting often mars the quality of the picture and this should be avoided. Either the early morning light or late afternoon light is best suited for this class of subjects and the pictures so taken will show interesting variety of light and shade, worthy of record.

The photographer should not be content with taking a single exposure of his subject but try the subject with different exposures and stops (with and without a filter) and from slightly different view points. The depth of focus and the definition for near and far objects should be correctly maintained and, to be on the safe side, an exposure or two with the next smaller stop should be given. The dull light in the forest calls for a generous exposure and this fact should always be borne in mind.

A high grade twin lens reflex film camera fitted with a F/4.5 lens in Compur Shutter is an ideal apparatus for the forest photographer. With its self erecting mechanism, simple manipulation and lightness it is preferred by many to the cumber-some stand camera which has hitherto been considered supreme.

With any camera it is essential for the operator to understand its use thoroughly by practising before setting out with it for a subject in the forest. A lens hood should be used as one may have to take a subject more or less against the light.

The focus should first be made on the focussing screen with the full apperture and the lens should then be stopped down (preferably to F/11 or F/22) to ensure a critically sharp focus over the entire area of the negative.

During exposures it is a good plan to keep the shutter set at the same speed and to vary the stops according to the light and subject. It should be remembered that close-up shots require longer exposures than those needed for subjects at a distance.

Great care should be taken in setting up the the tripod legs on slippery and uneven ground in the forest and the camera should be set on it in as level a position as possible to avoid distortions. It is for this reason only that some prefer a stand camera with the rising and falling front, cross movement of the lens front and tilting arrangement of the back.

Fairly fast pan or orthochromatic material should be used. But where colour correctness is essential it is advisable to use a pan film in conjunction with a light yellow filter.

The next problem that confronts the beginner is the length of the exposure. No hard and fast rules can be laid down for suitable exposures. It is a problem of vital importance requiring long standing experience to solve it. Exposure depends chiefly upon:

(a) the speed of the film used,

(b) the stop used,

(c) the condition of the light and the month and hour of the day when the photograph is taken, and

(d) the subject to be taken, whether of dark or light colour.

As a guide it can be stated that in fairly good light with an open foreground, an exposure of 1/50th second with F/11 on a fast pan film with light yellow filter on a summer morning would suffice. For a close-up shot in dull light the exposure should be proportionately increased.

The aim of the forest photographer should be to produce as fault-free a negative as possible so that sharply defined enlargements and lantern slides showing a good gradation of light and shade could be made with ease.

During winter the bare sky should never be included in the picture as it produces halation. When the sky has to be included, a lens hood

should invariably be used or the lens shielded with a piece of cardboard if the camera is not provided with a lens hood.

17. Cut-Flower Photographs including Orchids and Ferns.

Flower photography is a fascinating hobby and those interested in it will find endless subjects for their camera during off time at home. Forest photographers are often required to photograph varieties of orchids and ferns and wild flowers that grow in the forest for record, and to them the appeal of this class of photograph should be particularly strong as they can be taken indoors both in daylight and artificial light.

A stand camera with ground glass screen, triple extension bellow and various movements offers an ideal apparatus for this kind of work as with it, it is possible to photograph the subject to actual size at close range. But any other modern miniature camera having a focussing screen and supplementary lenses for a close-up will serve the purpose equally well.

The subject, which should be in fresh condition, is placed on a table in a well lighted room about six feet away from the source of the window light which falls at an angle of 45 degrees. This will offer good side light and the shadow side can be lightened by holding a piece of white towel, cardboard or paper towards it. Care should be taken not to allow any sun rays to fall on the subject and if this happens the window should be screened with a piece of white muslin. A northern window is to be preferred for even illumination.

The photographer should aim at a pleasing and artistic composition of the subject. He should first of all confine himself to taking the photograph of flower of a single colour and after acquiring sufficient knowledge attempt to take photographs of flowers, of different colours group together; in which case it is best to arrange the darker flowers nearer the window so that they may receive more light during the exposure.

Background plays an important part in this class of photography and due care should be taken to its selection and arrangement. White flowers or other light coloured flowers can be taken against a dark background by pinning a piece of grey cardboard or an increased brown paper on the wall behind the subject. For the darker varieties the white wall of the room may be utilised as a background.

The flowers can be supported by pushing the stalks into a lump of clay or damp soil placed on a dish on the table or they may be photographed with the pots in which they grow provided only one kind of flower is to be photographed at a time.

Panchromatic cut films or plates are best suited for these subjects and the fastest variety should be used in conjunction with a light yellow filter when exposures are made in daylight. With artificial light the use of the filter may be dispensed with. Endless experiments can be carried out with different sensitive materials and filters by a critic desirous of attaining perfection in this class of work.

The exposure should be generous and the lens may be used at full apperture for a quick exposure and artistic result when the portraiture of a single flower is taken. For groups of flowers the lens should be stopped down to F/8 or F/11 (according to the intensity of the light) in which case an exposure of one second will be found correct. Full exposure with shorter development will produce softer negatives for printing on a normal paper.

While daylight gives the best results there is no hinderance for these subjects to be photographed in the evening by any form of artificial light judiciously arranged for the purpose. It is best to eliminate the receptacle in the finished print.

Prints made on semi-matt or matt paper can be beautifully hand-cloured either in water colours or oils.

18. Miscellaneous.

(a) Keeping Powers of the Finished Prints.

If all the hypo that has been absorbed by the paper is not washed out, there is risk with every photographic print that the image will deteriorate after a time. In order to get the very best keeping quality from prints, it is very advisable *to place the fixed paper for one to two minutes* in a solution of anhydrous Sodium Carbonate of 1 p.c. strength, before washing. Washing is carried out afterwards in the ordinary manner.

(b) How to keep dishes clean.

A. Clean the dishes occasionally with a solution of :

Potassium Bichromate	2 ozs.
Water	18 ozs.

When the bichromate is completely dissolved and *the solution cold*, add 2 ozs. of sulphuric Acid. slowly with constant stirring.

This solution will burn the Fingers ; so apply it with a tuft of cotton wool on the end of a stick. Rinse under the tap after all the stains are removed. The solution can be used over and over again. It must be kept in a bottle with a glass stopper.

B. A solution of 3 p.c. Citric Acid should be made and kept in the dirty dish overnight. Next morning clean the dish with water.

C. Get a little commercial Hycrochloric Acid and dilute it with an equal volume of water. Pour some of this in the dishes and let it stand for some time; then pour off and clean out the dishes with plenty of water and a brush. Do not spilt the acid on your hands or clothes.

(c) **Focussing a Negative for Enlargement**

With very dense negatives it is often difficult to decide when the best focussing has been obtained, particularly when the degree of enlargement is considerable.

If a piece of clear film from which the emulsion has been removed, is painted all over with Indian Ink, it will be found, upon drying, that the ink breaks up into innumerable fine cracks, making an excellent fine-focusser.

(d) **The Function of the Stops in a lens.**

(a) To increase the depth of definition.

(b) To improve the definition when the camera is fitted with an inferior quality of lens.

(c) To cut the extra light reaching the film when the light is too bright, to avoid overexposure.

The reader will soon find that when a near object is in focus the distance object goes out of focus and *vice versa*, but within certain limits all objects come under the same sharpness. The extent to which the lens brings the objects at varying distances into the sharp definition is called the " depth of definition " (depth of focus). With full aperture the depth of definition or focus is less and it increases with the smaller stops used.

The smaller the stop used, the longer will be the exposure required as less light wi'l reach the plate. Double the exposure will be required for the next smaller stop, *i.e.*, if 1/100th. second seems to be the correct exposure for a subject when F/8 is used, it will require 1/50th. second for the same subject under the same condition if F/11 is used.

It is to be noted that to be on the safe side it is better to overexpose the film than make it underexposed. An overexposure has a remedy whereas an underexpoxure has none.

(e) **Stop-Bath for all Papers.**

Glacial Acetic Acid	..	..	60 mms.
Water	..	..	5 ozs.

OR

Potassium Metabisulphite		..	104 grs.
Water	..	..	5 ozs.

As soon as the print is developed it should be taken out and at once plunged into any of the two stop baths mentioned above. Treatment in the stop-bath should last at least for half a minute.

The print is then briefly rinsed and transferred into the fixing bath. Stop-bath arrests the developing action of the developer immediatey and thus ensures true whites.

(f) **Print Reducing Solution.**

Potassium Iodide	..	..	¼ oz.
Iodine	..	..	20 grs.
Water	..	..	10 ozs.

Wet the print first and then plunge into the above solution and rock the dish. Presently the highlights will turn blue and so the back of the print. When reduction has been completed the print is transferred *into a plain hypo bath* (not acidulated). When the blue has disappeared wash print thoroughly well and dry.

(g) **How to dry a glass negative without a drying rack.**

Fix a series of wire nails 1¼″ long 2″-3″ apart into one of the darkroom walls at a height of about 4 feet from the floor and let the nails project at least one inch outside. Take the plate negatives out of the last wash water one by one, and let each rest on a pair of nails by one corner. The tops of the plates should rest inclined on the wall. This arrangement

will not only drain the moisture quickly but there is very little chance for any plate to fall on the floor and break which often happens when it is left to dry on a wooden rack.

(h) **Characteristic feature of Panchromatic emulsions.**

Ordinary emulsions are sensitive only to blue and violet and are almost insensitive to green yellow and red.

Isochromatic emulsions such as, Verichriome Selochrome etc., are sensitive to green and yellow but they too are insensitive to red. For this reason these plates and films are loaded and developed before a red light in the darkroom.

Panchromatic emulsions are not only sensitive to blue, yellow, violet and green but are also sensitive to red. As they are sensitive even to the deepest red, their development should be carried out in total darkness. No darkroom light except a specially made safelight is allowed while a panchromatic film is developed.

Some prefer to desensitise the emulsion before development in which case it can be developed before a diffused white light at a distance of 4 feet from the source of light and the progress of development can be watched with ease. Desensitising a panchromatic film before development improves the printing quality of the negative on account of the dye laid on the film in desensitising.

A light yellow filter should be used with the panchromatic film for correct colour rendering. When the filter is used an increase of 1 to $1\frac{1}{2}$ times the normal exposure is required.

These emulsions are best suited for artificial light exposures and for exposures in the diffused daylight when all other emulsions fail.

(i) **Untoning a Print.**

A print that has been Sulphide-toned may be bleached and redeveloped to a black tone. The method is as follows:

Bleach-toned print in :—

Potassium Permanganate 1 p.c.	.. $\frac{1}{4}$ oz.
Hydrochloric Acid 10 p.c.	.. 1 oz.
Water to make ..	.. 5 ozs.

Wash, clear stain in Metabisulphite solution, rinse and redevelop, preferably in AMIDOL.

19. CHEMICALS.

Chemicals used for photographic purposes sould be pure, otherwise the results obtained will not be satisfactory. This is often not appreciated by the photographers. In compounding the developer care should be taken to see that all the ingredients are completely dissolved as undissolved particles in the solution would cause black spots on the print.

Particulars of just those chemicals which are mentioned in the chapter on Formulae in this article and used in every day photography are given below :—

Acetic Acid, sold as "glacial" which is the strength used in the formulae. It absorbs moisture from the air and must, therefore, be kept well stoppered.

Alum, known generally as potash alum, is obtainable both in crystals and powder form. It should be dissolved in hot water.

Chrome alum, is a deep purple crystalline salt which looks ruby-red by transmitted light. It hardens gelatine somewhat more energetically than do the ordinary white alums.

Citric acid, small colourless crystals easily soluble in water. It keeps indefinitely.

Glycine, is a white powder of minute thin plates, very slightly soluble in water but readily soluble in alkaline solutions.

Hydrochloric acid, called also muriatic acid. The pure commercial acid is a strongly funing corrosive liquid. It is a powerful cleanser of photographic dishes containing chemical deposits.

Hydroquinone, fine grayish-white needle crystals. It keeps well.

Hypo, (sodium hyposulphite, sodium thiosulphate) is obtainable in clear transparent crystals of hexagon shape. It is extremely soluble in water. It keeps indefinitely in solid form. As the hypo, when dissolved, cools the solution greatly, it is better to use warm or hot water in dissolving it or the solution prepared sometime ahead of work

so that it may regain the normal temperature.

Iodine, greyish lustrous violet scales. It should be kept in a stoppered bottle. It stains fingers etc. but the stain disappears in hypo or sodium sulphite solution.

Mercuric chloride, (corrosive sublimate) obtainable in heavy fibrous pieces or crys talline powder. The solution is very poisonous and should not be allowed to come in contact with the scratched skin of the worker.

Metol, is a white, crystalline powder readily soluble in cold water. It dissolves with some difficulty in sulphite solution. Hence in making up developers metol should be dissolved first before adding the sulphite in it. It keeps well.

Potassium bichromate, large orange-red crystals. A saturated solution mixed with about 1-20 the of its volume of sfrong sluphuric acid, is a powerful cleanser of almost all kinds of dirt from bottles and dishes. It can be used repeatedly. It keeps well both as solid and in solution.

Potassium bromide, obtainable as white powder or crystals dissolving in 1½ times of their weight of cold water. It keeps well in solid form and in solution.

Potassium ferricyanide (red prussiate of potash), obtainable in deep ruby-red crystals with a slight reddish coating. When rinsed in water the reddish coating diappears and the crystals are seen to be clear ruby-red. It dissolves in cold water. A strong solution looks yellow brown in colour but a weak solution is greenish yellow. In solution it does not keep well and should be stored in the dark. It must not be confused with potassium frrocyanide, which is seldom used in photography.

Potassium iodide, is sold in white small crystals readily soluble in cold water and keeps well both in solid form and in solution. It is chiefly used in dissolving iodine.

Potassium metabisulphite, is sold in transparent crystals which generally have a slight coating of white powder which is removed by washing. It dissolves readily in cold water forming an acid solution smelling of sulphurous acid. It should not be dissolved in hot water as in that case some of the sulphurous acid is driven off. It keeps fairly well in a well stoppered bottle in the form of crystals.

Potassium permanganate, is sold in small lustrous purple-red crystals and dissolves in about 16 parts of cold water. It stains the fingers deep brown when made in solution but the stain can be removed with a solution of metabisulphite or oxalic acid. In conjunction with sulphuric acid it becomes an energetic cleanser of dishes coated with developers. The brown stain which it leaves in the dishes is cleared with metabisulphite or oxalic acid.

Pyro, known also as pyrogallic acid or pyrogallol, is sold both in crystals and as fine snow-like powder. The powder dissolves more readily, but weighing the crystals is easier. The solution oxidises very rapidly unless some preservative is used in it, such as sulphite or metabisulphite. In making up developers the preservative should be dissolved first in water before adding the pyro. When the solution becomes dark it should be thrown away.

Sodium bi-sulphite, sold in the solid state and used in making up developers for films and plates.

Sodium carbonate, sold both in crystals and dry or anhydrous coarse powder form. One part of the dry carbonate is equal to 2½ parts of the crystals. It dissolves in cold water. It must not be confused with bicarbonate.

Sodium sulphide. In its pure state it is in small colourless crystals. It rapidly becomes moist by exposure to the air and is very soluble in water. It is sometimes met with in greenish looking crystals. Owing to its absorption of moisture from the air it should not be stocked for a long period. In concentrated solution it will keep for weeks but rapidly oxidises in a weak solution. Now-a-days it is also obtainable in the form of fused white opaque flakes which absorb less moisture from the air and so keep for a long time in a well stoppered bottle.

Sodium sulphite, is sold both in crystals and in powder form. The crystal sulphite should be in clear crystals without any powdery deposit on them. It must be kept in a well corked bottle. If any deposit forms, it can be rinsed in clean water for few seconds and the crystals dried on a

piece of cloth for weighing out. Dry or anhydrous sulphite is a white powder and, weight for weight, is twice as strong as the crystals. It dissolves more readily in water in powder form.

List of prepared developers which amateurs can use:

(a) Kodak D-76, obtainable in powder form in packages. Used for fine-grain development of high speed films and plates.

(b) Kodak DK-20, obtainable in powder form in packages, for extra fine-grain development of high speed films and plates.

(c) Johnson's Metol-Meritol, obtainable in powder form in packages, for extra fine grain development of high speed films and plates.

(d) Azol, obtainable in liquid form in bottles, for developing plates, films and papers.

(e) Certinol, obtainable in liquid form in bottles, for developing plates, films and papers.

(f) Ilford ID-20, obtainable in powder form in packages, used for developing Bromide and Chloro-Bromide papers.

(g) Kodak D-163, obtainable in liquid form in bottles, for developing Bromide and Gaslight papers.

(h) Kodak Acid Fixing Salt, for fixing plates, films and papers.

(i) Johnson's Mercury Intensifier. For intensifying weak negatives.

(j) Johnson's Chromium Intensifier. For intensifying weak negatives.

(k) Johnson's Sepia Tonner, for toning Bromide Chloro-Bromide and Gaslight papers.

(l) Johnson's Tabloid Developer, for developing plates and films.

BRITISH MEASURES AND WEIGHTS.

The formulae of this article are all given in British measures expressed in grains. In compounding developers it is customary to employ the avoirdupois ounce of 437½ grains.

1. Apothecaries Weight.

20 grains	.. 1 scruple.
3 scruples	.. 1 dram—60 grains.
8 drams ..	.. 1 ounce—480 ,,

2. Avoirdupois Weight.

437½ grains	.. 1 ounce.
16 ounces	.. 1 pound-7000 grains.

¼ ounce—109 grains; ½ ounce—219 grains; ¾ ounce—328 grains.

3. Fluid Measure.

60 minims	—1 dram.
8 drams	—1 ounce—480 minims.
20 ounces	—1 pint—160 drams—9600 minims.
2 pints	—1 quart—40 ounces—320 drams
4 quarts	—1 gallon—160 ounces—1,280 drams.

1 fluid ounce of water weighs 437½ grains, therefore every minim weighs 0.91 grain.

20. DEVELOPING ENLARGEMENTS WITHOUT DISHES.

Sometimes the photographer (especially the Professional) has to develop an abnormally big size of enlargement for which he does not possess the required dishes, and he cannot purchase them immediately for his work. In such circumstances the enlargement is developed and fixed in the manner described below:

After exposing the paper take it out of the easel and spread it, face upwards, on the cemented floor of the darkroom, which has been properly cleaned prior to enlarging. Get another assistant to help you. After spreading the paper on the floor put a weight on each of its corners so that it lies flat. Now both of you should sit, each at one end of the paper, holding in the right hand a big ball of cotton wool (bigger than a tennis ball). Soak the balls in clean water and damp the surface of the paper by working the wetted balls from the centre to the edges in a circular action taking care not to scratch the emulsion or injure its surface in any way.

When the paper has become limp, squeeze out the cotton balls, and wipe off the surplus water from its surface. Soak the balls again now in the developer, which should be kept handy and in enough quantity in an enamelled basin, and swab the surface with the developer quickly and evenly, covering the entire area of the paper, in the same circular action taking care not to allow any demarcation line of development to appear in the print. Continue applying the developer in this manner for about 1½ to 2 minutes till the print has gained full density.

Wash the print thoroughly now with a new set of cotton balls soaked in fresh water. Wipe off the surplus water as before, from the surface of the paper and fix the print for, about 10 minutes with the cotton balls soaked in the fixer, which should also be kept handy and in enough quantity in another enamelled basin.

When the print has been properly fixed switch on the white light of the room and wash it thoroughly for about half an hour with a fresh set of cotton balls and clean water. After washing hang the print to dry.

THE MAN-EATER OF JHABRAWALA IN RAMGARH SHOOTING BLOCK OF THE DEHRA DUN FOREST DIVISION.

By Capt. E. G. Melvill, Dehra Dun.

It was in March, 1949 that the man-eater, which subsequently came to be known as the man-eater of Jhabrawala, took its first victim—a member of the Forest Staff who along with several other men was marking trees above the 100 ft. fire line—he was suddenly pounced upon from the back and killed—but before the man-eater could eat its victim, it was driven off by the other men, and the body of the deceased was cremated in an adjoining dry river bed, where a heap of charcoal and half burned dry wood still mark his last resting place.

The second victim was a gujar who was on a tree cutting fodder for his cattle. He had one foot in the fork of a tree, and the other suspended below the fork. The man-eater suddenly sprang at his lower leg and tried to tear him down from the tree, but this brave and strong man clung to the tree, and the man-eater only succeeded in tearing the flesh of his thigh and leg right down to the bone. His cries of pain brought others to the scene, when he was taken down from the tree and carried to his home, where he died in agony.

During the first fortnight of April 1949, as a season permit holder, I made several attempts to contact this man-eater, but unsuccessfully. Young buffalo calves, tied up at nights in the areas frequented by it, were left unmolested, and it appeared that it had moved out of the locality. My specially built shikar station wagon was parked in a secluded spot on the 100 ft. fireline, which I made my headquarters, and from here I sallied out in all directions to contact the man-eater but without avail.

For the second fortnight of April, Ramgarh shooting block was allotted to somebody else, and my activities ceased till the first fortnight of May, 1949. On the 3rd May, 1949, I was back in the old haunts, and after a vigill of four nights, got information that the man-eater had taken up its headquarters 2 miles below my camp in very thick *Bansa* (*Adhatoda vasica*), and that it had attacked and severely wounded a young buffalo and a bullock, but that the villagers had managed to drive the man-eater off and had carried the wounded animals back to the village, where they had died soon after. A *boda* (bait) was immediately tied up in the locality where the cattle had been attacked, and on inspecting the place next morning, it was found that the *boda* had not only been killed, but entirely eaten up. Only the horns remained to tell the tale. A second *boda* was obtained immediately, and tied up in the same spot, but though it remained tied for eleven consecutive nights it was not killed.

For the second fortnight of May 1949, the block was allotted to another party, who gave me permission to continue my attempts to contact the man-eater. This I presented to Mr. Johri, the Divisional Forest Officer, Dehra Dun, forest division, who very kindly granted me written permission to try and shoot the man-eater. To my good fortune, I got information at 12.00 hours on the 17th May 1949, that this man-eater had killed a cow in calf in Jhabrawala at 18.00 hours on the 16th May, and I proceeded to the spot immediately. I was met by some Forest Guards and Fire Patrol guards, who guided me to the vicinity where the cow had been killed. As these men including the owners of the cow were unarmed and we were dealing with a man-eater, I asked them to keep away in case the man-eater was lying up by the side of the kill as was indicated by the absence of vultures, and that I would follow up the drag of the cow alone through the thick scrub, and face any charge that may be made. It was now 17.00 hours and there was every likelihood that the man-eater was by its

The man-eater of Jhabrawala shot by Capt. E. G. Melvill, on 17th May, 1949.

kill. So cautiously I entered the scrub jungle and noiselessly made my way along the drag to where I finally found the cow. The stench from the dead cow was terrific and I noticed that the cow had been eaten from the hind quarters, and that the killer had been lying up by the side of the kill.

The man-eater was absent at the time of my arrival, having gone for a drink of water, so I quickly put up my *machan*, and then tried to drag the cow out of the thick scrub into the open. Even with the assistance of the men, whom I had now called up, we were unable to move her, and the stench made the men sick to go near her. So I had the scrub cut and trodden down to give me a clear view of the kill from my *machan*, and sending the men away I commenced my vigil.

At 18-15 hours monkeys in neighbouring trees showed great uneasiness, and indicated that the man-eater was moving in the vicinity. Then quite suddenly at 18-20 hours the man-eater appeared from the scrub behind the cow, and immediately commenced to eat the gamey meat. On the first shot the brute fell dead by the side of the kill without a roar or struggle.

The animal turned out to me a Tigress, and measured 6ft. 8in. between pegs and 3ft. 1in. at the shoulder. (See Fig.) She was suffering from gunshot wounds apparently inflicted from the rear with a muzzle-loader gun with home made slugs, one of which had penetrated to the vicinity of her kidneys, whilst others had entered her hindquarters, and one had made a deep hole in her right hind leg above the pad, and was full of puss. I have recovered some of the home made slugs found in her body.

The Forest guard recognised her as the the man-eater of Jhabrawala that had killed two men in this locality, and the villagers recognised her as the same animal that had been wounding or killing their cattle since April 1949. The Tigress was also shown to the Range Officer at Lachiwala the same evening.

A NOTE ON THE CENTRAL HIMALAYAN CATCHMENTS.

BY J. BANERJI, M.A, I.F.S.

Project Officer (Soil Conservation)

A few Central Himalayan catchments were studied for Rainfall/Run off relations, and the results will be found in Table I. These catchments are:

(1) the Jumna at Tajewala, 4,300 sq. miles,

(2) the Ganges at Hardwar 9,030 sq. miles, and

(3) the Sarda at Banbassa 5,788 sq. miles.

They all stretch from north-west to south-east from Simla to Banbassa, and touch each other along prominent water-sheds.

2. The tentative conclusion is that these contiguous Himalayan catchments exhibit different run off characteristics for the same amount of rainfall. The run off per inch of rainfall per square mile of the catchment area increases from west to east, *i.e.*, the Jumna, the Ganges and the Sarda in an ascending order.

3. The data are incomplete and insufficient for further analysis. Annual snow-survey in the upper regions of these catchments is desirable for assessing the role of snow melt in the annual run off. More rain-gauge stations and temperature records are also necessary to establish a statistical relationship between rainfall and run off. A study of the nature and extent of vegetal associations, edaphic characteristics and average slopes will, no doubt, help in understanding the variations of the run off data.

4. Himalayan catchments are characterised by three zones *viz.*,

(1) the zone of glaciers with perpetual snow and ice;

(2) the zone of intermittent snow and ice; and

(3) the zone of no snow or ice. Each of these three zones show different run-off relations.

5. The average annual rainfall of the three catchments was calculated from the following stations:

(1) **The Jumna catchment (10 stations. 1928-1946)**

(*a*) Simla, (*b*) Chakrata, (*c*) Mussoorie, (*d*) Tajewala, (*e*) Dehra Dun, (*f*) Kalsi, (*g*) Ambari, (*h*) Kotkhani, (*i*) Paonta, (*j*) Khora.

(2) **The Ganges catchment (11 stations—(1928-1946).**

(*a*) Joshi Math, (*b*) Ukhimath, (*c*) Karanprayag, (*d*) Srinagar, (*e*) Pauri, (*f*) Bhogpur, (*g*) Raipur, (*h*) Rajpur, (*i*) Bhiron Khal, (*j*) Bhimgodh, (*k*) Laljeewala.

(3) **The Sarda Catchment (8 stations 1931 to 1946).**

(*a*) Kausani, (*b*) Chaukori, (*c*) Birinag, (*d*) Askot, (*e*) Pithoragarh, (*f*) Champawat, (*g*) Tanakpur, (*h*) Banbassa.

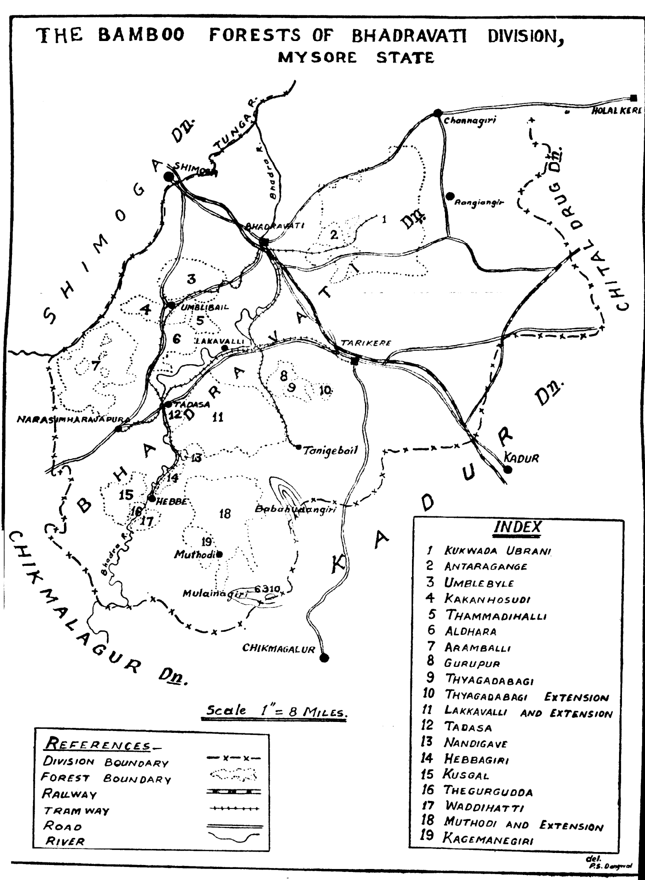
6. The percentages of theoretically maximum rainfall that flow away as run off are 51.82, 70.20, 82.39 respectively for the Jumna, the Ganges, and the Sarda respectively. The retention of rainfall is maximum for the Jumna catchment; the Ganges and the Sarda catchments come next in order.

TABLE I.

HIMALAYAN CATCHMENTS.

Years		*Jumna at Tajewala* 4,300 sq. miles		*Ganges at Hardwar* 9,030 sq. miles		*Sarda at Banbassa* 5,788 sq. miles	
		Rainfall (1)	Run off (2)	Rainfall (1)	Run off (2)	Rainfall (1)	Run off (2)
1928	..	61.27	1835	53.17	2368	*	*
1929	..	58.85	1692	51.94	2315	*	*
1930	..	64.10	1697	60.11	2820	*	*
1931	..	60.21	1877	56.28	2199	59.02	2604
1932	..	71.76	1932	63.90	2240	55.55	2433
1933	..	73.06	2268	69.44	2939	72.27	2810
1934	..	63.97	1987	64.96	2583	57.84	3077
1935	..	50.99	1729	50.15	2247	51.78	2292
1936	..	71.29	1655	81.18	2429	87.08	3310
1937	..	68.79	2089	74.50	1924	71.02	3084
1938	..	50.24	1623	64.59	2260	80.57	3735
1939	..	54.83	1171	51.12	1496	52.43	2227
1940	..	58.59	1249	60.21	1531	53.07	2433
1941	..	51.79	1157	48.84	1638	46.77	2183
1942	..	83.59	2342	82.00	3103	72.26	3036
1943	..	76.12	2176	67.86	2271	62.47	3310
1944	..	53.68	1388	51.15	2548	59.18	2364
1945	..	70.26	2098	65.47	3193	75.58	3438
1946	..	71.76	1614	69.52	2304	70.25	2787
Average		63.96	1767	62.44	2337	64.20	2820
Per inch of rainfall			27.63		37.43		43.93
1″ over 1 sq. mile			53.33		53.33		53.33
Percentage of the theoretical maximum			51.82%		70.20		82.39

(1) Average annual rainfall in inches
(2) Annual run off in acre feet/sq. mile of catchment area.



THE BAMBOO FORESTS OF BHADRAVATI DIVISION,
MYSORE STATE
SHIMOGA Dn.
CHITALDRUG Dn.
BHADRAVATI Dn.
KADUR Dn.
CHIKMALAGUR Dn.
TUNGA R.
Bhadra R.
SHIMOGA
BHADRAVATI
Channagiri
HOLALKERE
Rangiangir
UMBLIBAIL
LAKAVALLI
TARIKERE
TADASA
NARASIMHARAJAPURA
Tanigebail
KADUR
HEBBE
Babahudangiri
Muthodi
Mulainagiri
6310
CHIKMAGALUR
Scale 1" = 8 Miles.
REFERENCES—
DIVISION BOUNDARY
FOREST BOUNDARY
RAILWAY
TRAM WAY
ROAD
RIVER
INDEX
1 KUKWADA UBRANI
2 ANTARAGANGE
3 UMBLEBYLE
4 KAKANHOSUDI
5 THAMMADIHALLI
6 ALDHARA
7 ARAMBALLI
8 GURUPUR
9 THYAGADABAGI
10 THYAGADABAGI EXTENSION
11 LAKKAVALLI AND EXTENSION
12 TADASA
13 NANDIGAVE
14 HEBBAGIRI
15 KUSGAL
16 THEGURGUDDA
17 WADDIHATTI
18 MUTHODI AND EXTENSION
19 KAGEMANEGIRI
del.
P.S. Dangwal

Fig 1

ON THE ECOLOGY AND SILVICULTURE OF DENDROCALAMUS STRICTUS IN THE BAMBOO FORESTS OF BHADRAVATI DIVISION, MYSORE STATE, AND COMPARATIVE NOTES ON THE SPECIES BAMBUSA, ARUNDINACEA OCHLADRA TRAVANCORICA, OXYTENANTHERA MONOSTIGMA AND O. STOCKSII.

By K. Kadambi, M.Sc., D.Sc. (Munich), Dip. Forestry (Hons.)

Mysore Forest Service.

This paper deals with the bamboo forests which have been set apart for exploitation of the bamboo—*Dendrocalamus strictus*, for the Mysore Paper Mills Ltd. situated at Bhadravathi a place well known as the seat of the Mysore Iron and Steel Works. It deals with the bamboo growth of 18 state forests—Kukwada-Ubrani, Antaragange, Thamadihalli, Aldhara, Umbleyle, Kakanhosudi, Chornedehalli, Aramballi, Kugkal, Tadasa, Nandigave, Lakkavalli, Gurupur, Tyagadabagi, Hebbagiri, Tegurugudda, Muthodi and extension and Kagemanegiri—whose total area is 323 square miles.

The forests are situated on either side of the Bhadra and on the right bank of the Tunga, two important rivers running through some of the most valuable forest tracts of Kadur and Shimoga districts (Fig. 1.) Tramways radiating from Bhadravati, where the Mysore Paper Mills Ltd. are situated, are useful for tapping the forests.

Physical geography and configuration of ground.

The country is generally hilly and chains of fairy steep hills traverse most forests in all directions. In-between the hills the ground undulates with satisfactory drainage*. The northern portion of the area is comparatively less hilly than the southern where the Bababudan hill range is found. The hills rise barely over a thousand feet above the level of the surrounding country in the Channagiri and Bhadravati forest ranges and they are also seldom very steep. In the southern portion of the area, on the other hand, the precipitous Bababudans and their neighbours rise two to three thousand feet above the surrounding table land. The country is cut up into high hills and fairly deep valleys traversed by perennial streams, with beautiful mountain scenery. The central region, connecting the northern with the southern hilly portion, exhibits a transition between these two extremes. There is a belt of comparatively flat land free from hills in this region adjoining the course of Bhadra river.

Geological formations and nature of the resulting soil :—

The characteristic formations and the resulting soil of the tract may be broadly divided into three classes :—

(1) Granite and quartzite producing porous and sandy loam.

(2) Hornbendic trap and haematite yielding soft, ferruginous clayey loam.

(3) Chlorite or talc schist resulting in poor, impervious clay.

Kukwada-urbani, Antaragange, Tamadihalli, Aldhara, Umblebyle, Kakanhosudi and Chornedehalli contain granite covered with igneous and sedimentary schists and granite porphyry.

The forests which the second and third kind of rocks mentioned above have occupied are Kugkal, Tadasa, Nandigave, Lakkavalli, Gurupur, Tyagadbagi and extension and Kagemanegiri. The southern portion of Lakkavalli is characterised by hornblends, while chlorite schist is conspicuous in the north and west. In Muthodi a wide outer belt of hornblende encloses a narrow strip of talc schist in the centre of the forest. Tegurgudda and Hebbagiri are practically akin to Muthodi except that granite and gneiss crop up here and there in the west and south of these forests. In Kagemanegiri the hilly portions contain beds of magnetite and haematite-quartizite and iron ores of the Bababudan type.

Climate

Seasons—The year has three, well defined seasons, the rainy season which begins in June and lasts till October, the cold season which

* For a fuller description of these forests the reader is referred to the Revised Working Plan for the Forests of Bhadravati Division (1937), Chapter I, by the author.

starts in November and lasts till the end of January and the hot season which starts in February and ends in June.

Temperature.—The temperature varies within a minimum of about 60°F. and a maximum of 100°F. The hot weather is severe at Channagiri.

Rainfall.—The average, annual rainfall is 25.4 in. at Channagiri and 88.75 in. at Narasimharajapura. It is lowest in the north-east of the area and highest in the south and south-west of it. The bulk of the rain falls in the south-west monsoon, between June and August; September and October have less rain, while January, February and March have little or no rain. Occasional thunder storms occur in April and May.

The Forest.—The type to which the forests under consideration belong has been called elsewhere by the writer* "Mixed, Typically Deciduous". They have been termed "Moist-Deciduous" by H.G. Champion. The chief peculiarities of the growth are indicated by the name of the type. The trees are leafless during a certain part of the year and the onset of the dry season is foreboded by heavy shedding resulting in the forest soil being covered with a thick larger of fallen leaves. Annual recurring fires are a characteristic feature of the forests because the forest floor abounds in large quantities of heavily inflammable material during the dry season. The fires, when they occur, are capable of causing great damage by practically destroying all the natural tree seedlings or crippling them to such an extent as to make them unfit to yield timber and of destroying the bark and cambium of trees in the pole stage and making them quite unsound right from the start.

The bamboos—*Dendrocalamus strictus* and *Bambus arundinacea* have practically their home here as this type provides the optimum growth conditions required for them. They form a very important component of the forest crop and decide, more or less frequently, the conditions of growth and distribution of the tree species. The periodical, wholesale flowering of bamboos, apart from upsetting the balance of regeneration in these forests by suddenly opening up the canopy, has a deleterious effect in providing further inflammable material for fires which, at such times, often sweep the forests through spreading wholesale destruction before them. Annually, also, the fall of bamboo leaves is an important factor in causing ground fires. There is often little doubt that but for the presence of bamboos, the seedling regeneration and the quality of the tree growth would considerably improve in a short time.

These deciduous forests have been worked heavily in the past and large quantities of teak and *Terminalia* timber and firewood of all kinds have been removed from them.

CHIEF SPECIES.

The bamboos.—Large quantities of *Dendrocalamus strictus* (*kiribidaru* or small bamboo) and *Bambusa arundinacea* (*hebbidaru* or big bamboo) are found scattered throughout the forests. *Oxytenanthera monostigma* (*garte*) is found over fairly large, though localised, areas in the Lakkavalli and Tegurgudda forests. *Oxytenanthera stocksii* (*pannangi*) appears in small patches or as scattered clumps, adjoining streams or on high ground, and *Ochlandra travencorica* (*vatay* or reed-bamboo) is found in very small quantities and confined to the edges of perennial streams.

All the species of bamboo are gregarious in habit and form clumps. *Bambusa arundinacea* is the only one with thorny branches.

The tree species.—The principal tree species are:—*Tectona grandis* (teak), *Dalbergia latifolia* (rosewood), *Terminalia paniculata* (*hunal*), *Lagerstroemia lanceolata* (*nandi*), *Petrocarpus marsupium* (*honne*), *Grewia tilaefolia* (*tadasal*), *Adina cordifolia* (*yethyaga*), *Stephegyne parvifolia* (*kadavala*), *Stereospermum chelonoides* (*lingadri*), *Anogeissus latifolia* (*dindiga*) *Dillenia pentagyna* (*kanagalu*), *Eugenia hambolana* (*nerlu*), *Albizzia odoratissima* (*bilwara*) and *Terminalia belerica* (*tare*).

DESCRIPTION OF DENDROCALAMUS STRICTUS (NEES)†

Dendrocalamus strictus (Nees), the principal bamboo of this paper, is a medium sized, densely tufted, generally deciduous bamboo, with strong, thick walled or solid culms varying in size according to the locality. The young foliage appears in April-May and is bright green; the old leaves turn yellow and fall at the beginning of the hot season (January-February), except on moist sites where they remain more or less green practically throughout the year. The new culms are glaucous green when young,

*Kadambi, K., Working Plan Manual, Mysore, 1944.

†The excellent Indian Forest Record by P.N. Deogun (I.F.R. Vol. II, No. IV) has been freely quoted throughout this paper.

losing their glaucous appearance in later years and often turning yellow before death. The stem sheaths are up to 10 in. long with very small auricles, narrow ligule and triangular pointed blade; they are covered on the back with stiff golden brown hairs and the margins are ciliate. The culms are 20 to 40 feet high (Mysore) and 1 to 4 in. in diameter with the internodes 10 to 15 in. long. Short branches are produced at the nodes all along the upper part of the culm. The size of these branches varies a good deal in different localities, and they become much larger if the growth of the culm is checked by breakage or insect attack. Generally the few lowest nodes and occasionally the higher ones produce rootlets. Flowering takes place in the hot season—January to April —and the seed is ripe by June. A severe drought may hasten (according to Deogun) the flowering and fruiting.

Deogun has recognised three main forms of *Dendrocalamus strictus*, which are called by him: (1) The common type (2) The large type (3) The dwarf type. Only the common type is found in Mysore. This type is again subdivided by Deogun into three minor variations as follows:—

(*a*) Culms with moderately thick walls,—this is the form found everywhere in Mysore.

(*b*) Culms hollow with relatively thin walls, —not seen in Mysore so far.

(*c*) Culms solid or nearly so,—This is found occasionally in the dry plains forests. It does not attain big sizes.

Dendrocalamus strictus is found in deciduous forests throughout the greater part of India except in portions of West-Bengal and Assam. It is also common in most of the hilly parts of the Indian peninsula except in very moist regions.

Within its climatic habitat in India and Burma, it grows on practically all kinds of soils provided there is good drainage—sandy loam (Madras), gravels (Punjab), poor shallow clays, coarse sand, medium and heavy calcareous soils (Burma), alluvial soils near banks of streams (Bombay), coarse grained dry soils such as those derived from sand-stone, granite and granitic gneisses (Orissa), etc.

A minimum of 30 inches and a miximum of 200 inches of average annual rainfall and a maximum shade temperature of 116° F and minimum of 22° F are recorded for the *Dendrocalamus strictus* bearing localities of India. Atmospheric humidity is said to be one of the determining factors in the distribution of this species. This bamboo, according to Deogun, prefers hilly ground and is of better quality on cooler aspects. In general it stands drought better than any other kind of bamboo.

Habitat distribution of the bamboos.

Dendrocalamus strictus occupies by far the largest portion of the area under description and is confined generally to well drained hill slopes or undulating ground with adequate drainage with an elevation between 2,000 and 3,000 feet. It is highly intolerant of bad drainage or heavy clayey soils. In short, it demands the best of quality of locality and drainage. Good quality teak is generally associated with this bamboo.

In general *Dendrocalamus strictus* thrives best on porous, gravelly and sandy loam on a bed of granite rock and moderately well on ferruginous loam lying over hornblends. It does not seem to do well on chlorite schists as may be seen in the north-western portions of Lakkavalli and eastern portion of Aldhara. It withdraws itself from the more moist localities leaving them in favour of *Bambusa arundinacea*, and a dense overhead forest cover is very unfavourable to it, as is the case, generally, with all kinds of Indian bamboo.

The best developed clumps of *Dendrocalamus strictus* are found in Aramballi, Aldhara, Kakankosudi, Chornedehalli and the northern portion of Lakkavalli forests, although the culms, though not so stout, are longer in the moister zone of Tegurgudda and Muthodi forests. Next to *Dendrocalamus*, *Bambusa arundinacea* is most abundant and it generally occupies all the ground adjoining rivers, streams or large tanks. It demands more of soil moisture, generally tolerates even a certain amount of inundation during the rainy season, is capable of withstanding moderately heavy or clayey soils to a considerable extent, and owing to the intolerance of *Dendorcalamus* of such localities, it is found in an almost pure state in such places, abandoning the higher, drier, better drained slopes for that bamboo. In mixed-deciduous forests of first quality it occasionally covers the entire forest, and scattered well grown clumps of *Bambusa arundinacea* are, therefore, deemed a characteristic feature of this quality forest. This bamboo does not on the whole seem to be very particular about the kind soil so long as it enjoys plenty of moisture. It is, therefore, found abundantly in low ravines and moist valleys and also along water courses but, as a rule, it avoids dry slopes and open ridges.

Oxytenanthera monostigma (*Garte*)—where it occurs this is generally confined to the tops of ridges and hills. It stands generally on shallow soil sometimes with outcropping quartz on hill ridges and among all the bamboos mentioned here this is, perhaps, the least exacting as regards fertility and depth of soil, as it is confined to localities generally high and dry. It is, however, *the most light demanding* of the bamboos, shunning even moderate side-shade. *Garte* thrives well on quartzite, *e.g.*, the top of Bilikal-Rangappangudda in Umblebyle forest and also on hornblendic and ferruginous rock *e.g.*, in Tegurugudda and Lakkavalli forests. Its occurrence on rocky, shallow soils is probably not so much due to its special liking for such localities as to the fact that it is driven out of more favourable soils by the more aggressive *Dendrocalamus*. This factor combined with its extreme intolerance of overhead light is very probably responsible for the localised distribution of this bamboo on hill tops and ridges. The bamboo has practically its home on the Salbakkegudda and Sukalatti-hill in Lakkavalli forest. In the southern portion of Aramballi forest it is not strictly confined to hill tops or ridges.

Oxytenanthera stocksii (*Pannangi*) is generally confined to the banks of streams, perennial or otherwise, but it sometimes occurs on hill slopes and at others on undulating land; in other words its demands on soil are nearly similar to those of *Dendrocalamus*—good drainage on deep loam—except that it loves moisture more than that bamboo and is therefore more often seen on the borders of hill streams or in rainier localities.

Ochlandra travancorica (Reed bamboo) is somewhat like *Bambusa arundinacea* and confined to the neighbourhood of streams but, unlike it, it prefers running water and is therefore found exclusively along perennial or semi-perennial streams. It is therefore confined to forests with heavy rainfall such as Muthodi and Tegurgudda. The natural home of this bamboo is the ever-green forest zone of Mysore.

Proceeding, therefore, from a major forest stream up along its adjoining slope and on to a hill top one sees the following picture of bamboo distribution :—

At first, immediately adjoining a stream, may be seen a dense growth of large clumps of tall, well formed *Bambusa arundinacea* which gets scarcer gradually as we leave the stream. On ascending the adjoining slope *Dendrocalamus strictus* appears and, before long, occupies the ground almost exclusively. Occasionally a few clumps of *Oxytenanthera stocksii* (*pannangi*) may be found amidst *Dendrocalamus strictus* along streams or on the lower hill slopes. On reaching the tops of hills a pure patch of *Oxytenanthera monostigma* may appear which generally stands in the open, *i.e.*, without any appreciable overhead forest cover.

Growth qualities of the mixed-deciduous forest.

Three sub-types (growth qualities) can be distinguished in the mixed-deciduous forest type, controlled primarily by edaphic factors. They are :—

(1) *THE SUB-TYPE ON DEEP SOIL WITH GOOD QUALITY OF LOCALITY.*

(2) *THE SUB-TYPE ON SHALLOW SOIL WITH POORER QUALITY OF LOCALITY.*

(3) *THE DRY AND FREQUENTLY ROCKY SUB-TYPE.*

To these must be added probably a fourth—the swamp sub-type—which consists of open, grassy blanks occurring as islands within all three sub-types; here are found occasional trees of *Careya arborea*, *Butea frondosa*, *Randia uliginosa*, *Zizyphus xylopyrus* and stunted *Terminalia tomentosa*. This sub-type is usually free from bamboo, but *Bambusa arundinacea* may be found along its edge.

Sub-type (1).—This includes mixed-deciduous forest of the best quality in Mysore—quality I.—which is frequently called "A-type forest". This may be called the home of *Bambusa arundinacea*. It is characterised by trees having tall, well formed boles, a limited number of tree species and a good proportion of *tall, well grown, clumps of Bambusa scattered throughout it.* This bamboo enjoys its optimum of growth requirements in the sub-type and develops into a stately size and may form "breaks" along water courses. Portions of Lakkavalli, Muthodi, Armaballi, Hebbagiri and Nandigave forests belong to this type (*vide* statement below).

Sub-type (2).—This includes mixed-deciduous forests of medium quality—Quality II—which is frequently called "B-type forest." This is the home of *Dendrocalamus strictus*. It is characterised by a great variety of tree species and *the existence in it of large quantities of Dendrocalamus strictus of the best quality of growth*, because

this bamboo enjoys here, its optimum ecological factors. In this sub-type *Bambusa arundinacea* is confined to the banks of streams, perennial or otherwise.

Sub-type (3).—This includes mixed-deciduous forest of poor quality, frequently called "C-type forest". This generally contains a lot of *Dendrocalamus strictus*, although the clumps do not develop to their best sizes. Hill tops are generally free from bamboo in this sub-type, but hill slopes and the undulating ground adjoining the banks of streams, most of which are dry in summer, bear scattered growth of clumps. *Bambusa arundinacea* is confined in this kind of forest to the banks of the perennial or semi-perennial streams, if any. Over fairly large areas of this sub-type there is frequently no bamboo growth of any kind.

The following statement shows the distribution of the area of each reserve forest among the three ecological sub-types—(Figures adopted from the Working Plan of Bhadravati division by the author.).

Reserve forest (name).	Mixed-deciduous type Sub-type I (acres).	Sub-type II (acres).	Sub-type III (acres).
1. Kukwada-ubrani	..	26,469	18,561.0
2. Antaragange	..	5,297.0	6,658.0
3. Tamadihalli	..	..	2,406.0
4. Aldhara	..	3,723.6	4,989.2
5. Umblebyle	..	..	7,880.6
6. Chornedehalli	..	3,138.0	2,391.0
7. Kakanhosudi	..	2,927.0	1,476.0
8. Aramballi	7,424.0	4,976.0	3,075.0
9. Kusgal	..	5,850.0	3,986.0
10. Tadasa	..	2,306.0	644.0
11. Nandigave	815.0	168.0	..
12. Lakkavalli	16,936.6	14,583.6	6,741.2
13. Gurupur	..	..	5,388.0
14. Tyagadabagi	..	..	6,112.4
15. Hebbagiri	2,645.0	2,577.0	..
16. Tegurgudda (Waddihatti)	..	504.0	..
17. Muthodi and extension	21,456.4	1,292.0	..
18. Kagemanegiri	..	4,567.0	..

Gregarious and sporadic flowering.

Some sporadic flowering takes place every year in practically all *Dendrocalamus strictus* areas, but gregarious flowering in one locality occurs only after a long period of years. In sporadic flowering one or more clumps in a locality or *even one or a few culms in a clump* or few clumps in a certain area may flower. In Mysore it has been observed by the writer that every stage of transition from the typically sporadic to the typically gregarious kind of flowering may occur. For example in 1932-33 while almost wholesale (gregarious) flowering occurred in Muthodi and Kagemanegiri forests its intensity gradually diminished on proceeding towards north and east through the forests Hebbagiri, Tadasa, and Lakkavalli till it dwindled down to the flowering of only a few stray clumps in Aldhara and Gurupur forests. In other words the flowering was reduced from the gregarious to the sporadic condition. A similar state of affairs occurred during the 1943-44 flowering which enveloped the bamboo crop of Umblebyle, Kakanhosudi, Aldhara and Aramballi forests. The flowering was typically gregarious in Umblebyle but gradually diminished in intensity and was reduced to an almost typically sporadic condition in the southern portion of Aldhara and Aramballi forests.

Flowering generally takes place from November to February. The seeds are ripe and they shed from April to June and germinate in the ensuing rainy season. The culms retain their leaves during the early part of the flowering (November) but gradually lose them until by February they become entirely leafless and only the flowers are left. With the fall of the seeds the culms start drying from top downwards. With the death of the culms after flowering the rhizomes from which they spring also die.

Records of past flowering of *Dendrocalamus strictus* in Mysore are incomplete or incorrect. It is advisable for the District Forest Officers and others to record the occurrence of gregarious flowering in state forest journals and periodical reports giving definite description of the limits of the locality and the time of the year at which the flowering occurred and whether the areas were under proper working or maltreatment of any sort and any climatic peculiarities at or before the time of flowering. A complete record of the progress of a gregarious flowering is well worth making whenever opportunity offers.

In 1917-18 wholesale flowering of *Dendrocalamus strictus* is reported to have taken place over the eastern portion of Aldhara and the north-eastern portion of Lakkavalli. It was then observed that within the flowered area there were several isolated clumps which had not flowered. The next wholesale flowering of this bamboo occurred in the years 1932-33 over the greater portion of area under report, the forests affected being Lakkavalli, Tadasa, Hebbagiri, Muthodi, Kagemanegiri, Kusgal, Tegurdudda and Waddihatti. The writer visited the flowered areas in 1935, when he saw from the condition of the natural regeneration that the flowering had rolled on gradually from the south and south-west to the north and north-east directions in the course of about two seasons. Fierce forest fires followed the death of the bamboo to be accompanied almost immediately thereafter by copious natural regeneration. About the other forests, and especially Kukwada-ubrani and Antharagange, no records exist of the date of last flowering, but a careful examination of the clumps leaves little doubt that the crop here is older than in Aramballi, Aldhara and Umblebyle.

The following information was gathered by the writer through personal observations made during his service in the State:—

Year of gregarious flowering	Locality-state forests	Remarks (Bamboo)
1932-33	Muthodi, Kegemanegiri, Tegurgudda, Hebbagiri, Tadasa, Lakkavalli (part), Gurupur (part) and Kusgal (part), all in Bhadravati division.	*Dendrocalamus strictus*, No systematic working.
1940-41	Northern half of Begur, in Mysore division.	do

1942-43	Bilidale, Ramadavarabetta, Chowrakal, Banumanakal etc. of Bangalore division.	*Dendrocalamus strictus,* No systematic working.
do	Dodharve, Kalammankumri, Cauvery, Handigudda (Gulladahalla) and the adjoining unreserves.	Flowering not typically gregarious, but a high proportion of clumps flowered.
1943-44	Umblebyle, Kakanhosudi, Tamadihalli, Aldhara and Aramballi of Bhadravati division.	*Dendrocalamus strictus.* No systematic working.
1943-44	Agumbe, Balehalli, Chokkadabyle, Kunda, Sirur and the adjoining unreserves of Shimoga division.	*Oxytenanthera monostigma.* Not systematically worked.
1944-45	Kakankote, Begur, Ainurmarigudi (southern portion) and the adjoining Indian Union territory of Madras in Wynaad and Nilgiri districts.	*Bambusa arundinacea.*
do	Aramballi state forest, Bhadravati division.	*Ochlandra travencorica.*

Life-cycle of Dendrocalamus strictus.

The latest flowering of *Dendrocalamus strictus* in the forests Lakkavalli, Tadasa, Hebbagiri and Muthodi occurred in 1932-33 and from the records available, the one previous to it occurred between the years 1905 and 1908. It is believed that the period that lapses between two gregarious flowerings over the same area is more or less constant for each species of bamboo and this period is referred to as the "life cycle" of bamboo. The life cycle for this bamboo in this locality lies therefore between 25 and 30 years. Deogun has recorded the following life cycles for the bamboo in different states of Central and South India as below: Madhya Pradesh—Chanda, 21 years; Seoni, 22 years; Balaghat, 20 years; Madras—Vaishakapattanam, 28 years. North of the Vindhyas the life cycle of this bamboo seems to be longer having been recorded as being 36 years in Gharwal (Outer Himalayas) and 40 years in Saharanpur Siwaliks (Uttar Pradesh). The general conclusion is that the life cycle for *Dendrocalamus strictus* in any particular locality is more or less constant but differs in localities which have appreciable differences of climate and soil.

From a careful observation of the course of the sporadic flowering it could be stated that the clumps which flower sporadically do so not because their life cycle is shorter than those of the remaining clumps in the locality but probably *because they belong to a separate life cycle.* In the absence of records of the dates of flowering of individual, sporadically flowered clumps the writer is not able to say whether the length of this life cycle differs from that of the rest of the crop or is the same, but he is convinced by careful observation of the fact that sporadic flowering of *Dendrocalamus strictus* takes place because the bamboo crop consists of a mixture of clumps with different but overlapping life cycles. In other words the bamboo crop consists of a mixture of clumps of varying age each of which flowers as and when it completes its life cycle. This observation is supported by the fact that in walking through any crop of *Dendrocalamus strictus*, one sees small patches of natural regeneration, often not more than a dozen square yards in area, and of almost every age class from the seedling stage to nearly full grown clumps. Such regeneration belongs to clumps which have flowered sporadically and will again form clumps which will be among the sporadically flowering ones amidst the next, gregariously flowered, generation of bamboo clumps.

Causes of flowering.

It is likely that bamboo may have a more or less fixed reproductive age and this age may be affected by influences which hasten or retard it. Climate seems to influence flowering since very dry years (famine years) are said to coincide with the flowering of bamboo, and bamboo in exposed situations flowers earlier than in sheltered or cooler places. The period which lapses between two flowerings probably represents the physiological life cycle of the bamboo.

Before flowering accumulation of food material has been noticed in the rhizomes and systematic working of clumps may retard the formation of reserves by directing the growth of the plant to vegetative channels.

Indications of an approaching flowering.

Generally, the non-production of new culms in any year is an important event foreboding an approaching flowering; but Deogun, after quoting a number of exceptions to the above, has concluded that at present no signs are known by which flowering can be predicted. The author cannot wholly subscribe to the above view. Another, though less reliable, indication is the fact that the culms in a clump bend outwards more and more probably as a result of the decreasing internal turgidity resulting an increase in width of the clump. crown and increased space among the culms in the upper half of the crown.

Vitality of seed from sporadic and gregarious flowering.

The occurrence of copious natural regeneration of all ages and sizes as a result of the sporadic flowering of clumps all over the *Dendrocalamus strictus* areas indicates that seed from such flowering is as fertile as any other. Germination tests of cleaned seed made by the writer indicated viabilities of 50 to 90 per cent for such seed. Deogun has also mentioned that tests in Dehra Dun on seed obtained from sporadic flowerings do not show that it is poor in quality.

Bambusa arundinacea :—Except as a prelude to wholesale flowering, flowering of individual clumps does not take place in this bamboo. It is known to flower gregariously over extensive areas—far more extensive than *Dendrocalamus strictus*—at almost the same time; consequently one can correctly estimate the age of the crop in a locality. It is known that over the whole of Muthodi, Kagemanegiri, Tegurgudda, Waddihatti and Kusgal, major portion of Hebbagiri and Lakkavalli and the eastern fringe of Aramballi, this bamboo flowered in the years 1905-06. In 1917-18 the crop was described as "just passing from the thicket stage to adult size", and that some big exploitable culms 9 to 12 inches in girth and 50 to 60 feet in height were being formed in the moister forests. Over the major portion of Aramballi and the western portion of Hebbagiri gregarious seeding took place in 1912-13 and the new crop was in the thicket stage with small clumps by 1918. In the north-eastern portion of Lakkavalli, to the east of a line drawn on the map from Oswald teak plantation southward along Chandiankere to meet the Sampigekan road, and over a few patches in the south-east of Aldhara forest wholesale flowering took place in 1917-18. It was also observed that in the growing season before the flowering no new culms were produced; when this phenomenon is observed over a wide area it is probably a sure indication that a flowering is impending.

Oxytenanthera monostigma and O. stocksii :—The crop is generally confined to limited areas governed by the edaphic factors already described. The flowering is both sporadic and gregarious. The former bamboo flowered gregariously in Aramballi state forest in 1945. Any estimate of the age of the latter is not possible as no records exist of the date of last flowering. The crop, so far as it could be judged from its present condition, is in its adult stage.

Ochlandra travancorica (Reed Bamboo): —Like *Bambusa arundinacea* in mixed deciduous forests, the reed bamboo is fond of fringing the perennial streams in sub-evergreen and evergreen forests. Its flowering is gregarious and is said to take place once every ten to fifteen years.

Growth of the seedlings of Dendrocalamus strictus :—According to Deogun, the plumule emerges on germination of the seed in the form of a pointed conical bud with sheathing, scale like leaves, which rapidly develops into a thin, wiry stem bearing single foliage leaves arising alternately at the nodes, the bases of the leaves sheathing the stems; meanwhile, fibrous roots develop adventitiously from the base of the young shoot. A tufted form commences to show itself at an early stage. This is effected by the production on the rhizome of successive, pointed buds, from which are developed branch rhizomes which curve first downwards and then upwards before emerging as aerial shoots so that the successive shoots, besides being larger than the preceding ones, arise from rhizomes deeper in the ground (Deogun).

Time of production of new culms :—New culms of *Dendrocalamus strictus* generally begin to appear after the middle of July and continue coming up till the end of August in the *malnad* (wet zone) of Mysore, but the time of production is less regular in the dry plains, where they may be observed to emerge from July to October depending upon the intensity

of rainfall. In the case of *Bambusa arundinacea* the production of new culms begins from a fortnight to three weeks earlier. This difference is probably due more to inherited factors than to the availability of moisture, since clumps of the two kinds of bamboo though standing side by side invariably exhibit this difference.

Position of new culms in the clumps :— New culms arise from rhizomes of the last or previous year's culms, or if rainfall is favourable, from even older (3 to 4 year old) rhizomes, but rarely from rhizomes of still older culms. The new culms generally spring from rhizomes which carry culms in full vigour (Deogun).

Rate of growth :—The new culms protrude from the ground as scaly cones and grow by the elongation of the internodes which takes place at a rate which depends chiefly upon weather conditions, principally rainfall. A long break in the monsoon rains may arrest the growth of a culm which has commenced its elongation. The bamboos attain their full height within 8 to 12 weeks. The development of lateral branches takes place during the second growth season except when the terminal portion of the culm gets damaged, in which case the side branches develop briskly. Some data of the rate of growth have been recorded in Mysore by M.V. Narasimniah in 1918 and by the writer between the years 1937 and 1945 which will be found in the latter portion of this paper.

Size of new culms :—In a clump which is still in the process of formation the successive years' culms under normal conditions of growth show bigger sizes, till they attain mature size, after which the new culms are all generally more or less of the same size.

Formation of clumps :—The formation of clumps in the case of single plants is normally effected by the gradual spread of the plant from the centre outwards. Two separate rhizomes may join up and give the appearance of one, or separate clumps may be formed by the unilateral growth of the rhizome and subsequent separation of the connecting portion.

SOURCES OF INJURY

Fire :—This is the worst enemy of bamboo forests, and it is so because bamboo reciprocates to fire by providing large quantities of readily inflammable material in the form of dry leaves shed by it year after year throughout the fire season. But for the existence of bamboo the annual repeated ground fires of our forests would be denied their ready feed of inflammable material and the fires would not have been able to spread rapidly. Every gregarious flowering and death of bamboos ends in causing disastrous fires whose ravage is often indescribable; wholesale destruction or at least crippling of the forest tree stand takes place resulting in inestimable loss of timber. Ground fires do not generally damage the bamboo rhizome, but heavier tree fires, when they occur, very often kill it outright. Fire scortching often, though not always, sets up a sort of a stimulus to the production of new culms, or to the formation of switchy, very rapid growing shoots which, however, should be looked upon as a pathological effect.

Although rigid fire protection has been the avowed policy of the administration it cannot be said that much success has been achieved in this respect at any time. Seasonal fires are of regular annual occurrence, and this is due to the fact that the forest staff is generally very heavily engaged on exploitation work during the worst part of the fire season. The fire season coincides with the open season when most forest operations must go on, and the forest is generally full of cartmen, axemen, charcoal burning coolies, railway gangmen, men collecting minor forest produce and other right holders, purchasers or license holders and all these will be there in addition to the permanent resident population of the forest villages. A number of tramlines run through the forests and the steam engines which traverse them are also to some extent responsible in originating fires.

Any fire protection scheme, apart from preventing the entering of fires from without, should, as far as possible, control the actions of the forest labour and population resident within the forests. Fire lines are not of much use unless they are kept clean of falling leaves at frequent intervals and fire tracing is repeated during the fire season. Without a very large protective staff the prevention of forest fires in the working areas is next to impossible. In more recent years, therefore, rigid fire protection has been confined generally to compact blocks of plantations. Fire lines are made all round blocks of successful plantations, and these are kept free from inflammable material by repeated cleaning up; fire patrols are engaged to supplement the forest staff during fire season in keeping plantations free from fire and a large measure of success has been achieved in this connection. The natural forest is, however, run over by fire year after year, and bamboo extraction only encourages forest inflam-

mability by adding to the debris. The position is well summed up in the following words extracted from the author's Working Plan Report of the Bhadravati division (page 50) :—

> "One decade of absolute fire protection to a forest might add as much to it as a whole rotation long of improvement fellings. But the inflammability of the forests during the dry season, the existence of numerous rights of way throughout the year and the constant running of trains render the task of fire protection extremely difficult in our forests."

Drought:—Rainfall is one of the most potent climatological factors affecting the growth of the annual culms. That this is so has been established by means of investigations in the experimental plots of *Dendrocalamus strictus* maintained by the Working Plan Branch since 1936. If the monsoon rains fail in any year, that year the production of new culms is considerably minimised, and the few culms which are formed are generally smaller than culms of years with a normal rainfall. In 1938, for example, the growth of new culms which had already emerged from the soil was arrested for several weeks owing to the failure of rain. Each year, the date of emergence of the new culms from the ground is closely linked up with the days of adequately heavy monsoon showers and the postponement of the monsoon results invariably in a postponement in the emergence of new culms from the underground rhizome.

The following information on injuries during various stages of the growth of *Dendrocalamus strictus* has been taken from P.N. Deogun's I.F.R. Vol. II, No. 4.

(1) **Enemies in the seedling stage.**—Among them are rats and porcupines which gnaw through the rhizomes and bases of culms, squirrels which gnaw the tender, growing shoots, pigs which dig up and eat the rhizomes, hares, deer, goats and cattle which browse and trample young seedlings.

(2) **Enemies in the clump stage.**—(*a*) **Monkeys** and **langurs** (*Pithecus entellus*) are probably the worst enemies of tender shoots. This source of damage is severe in particularly dry seasons when other more palatable food is not available. (*b*) **Elephants and other wild animals.**—Wild elephants are the worst offenders in Mysore district as they pull down, trample and destroy whole clumps resulting in the development of bushy growth over the area generally haunted by them, but there are no wild elephants in the area under report. Spotted-deer do considerable damage to new culms during the rains.

(*c*) **Insects.**— (*i*) *Estigmina chinensis* (*Chrysomelidae*) attacks growing culms only, reducing the length of the internodes or making them crooked and forming a source of congestion of clumps.

(*ii*) *Cyrtotrachelus longipes* (*Curculionidae*), is a weevil which attacks growing tops of new culms and eats out the top bud.

(3) **Insect pests on cut bamboos**:—The insects *Dinoderus pilifrons*, *Bostrichus parallelus* and *Stromatium barbatum* are all said to attack cut culms, while *Dinoderus minutes* attacks both cut and living ones. According to J. N. Sen Gupta some States complain of serious insect attack and animal damage following the first working, but the incidence is low thereafter.

In Mysore the most serious damage to cut bamboos is caused by the minute beetle *Dinoderus minutes* whose pin holes are visible on the outer surface of the attacked bamboos. The larvae of this beetle riddle the inside portion of bamboos and fine, white dust falls out when such bamboos are shaken. These attacks are found among the bamboos cut and stored but not among the living ones. In the experimental daily collection of bamboos made for the Paper Factory which were stored in the open there was scarcely any attack among the bamboos collected in the rainy season; there was a little more among the cold weather collections, though on the whole the incidence was low, but this increased rapidly in the warm months and reached its peak at the height of summer which is March-April in these parts. There is a strong popular local belief that bamboos cut in the dark fortnight of a month are immune to insect attack. This was not borne out by the experimental collections in which bamboos collected in both fortnights of summer months were equally well attacked. In summer the bamboos contain more starch and this may be one of the causes favouring beetle attacks. Immersion in water immediately after cutting is known to be one of the best treatments against such attacks but favourable conditions for this treatment do not generally exist all over our forests. Anyway the most important precautionary measures that could be taken against beetle attacks is to restrict bamboo cutting to cold and rainy periods. *Dinoderus minutes* attacks all the five

kinds of bamboo mentioned in this paper but the experiments conducted in this connection showed that the incidence of such attack is very much less for *Bambusa arundinacea* compared to others.

(4) **Fungus.**—Though certain types of fungi are seen among bamboo collections the damage caused by them is insignificant. Black sooty moulds are often seen on the surface of bamboos collected during moist weather but these cause no damage to the inner layers.

(5) **Grazing.**—Cattle trample and destroy or devour the tender culms, and unrestricted grazing of cattle causes considerable injury to clumps in the growing season.

(6) **Man.**—The damage from man is inconsiderable. A certain amount of injury is caused by unsystematic fellings by license holders, who hack all culms—young or old—leaving high stumps which dry back, rot and feed fires, or clearfell clumps with disastrous results on them. Man also lops culms for fodder, cuts growing culms for food and injures the clump in several other ways.

The utility of bamboos.

In Mysore, as probably also in some other parts of India, considerable areas of rich bamboo forest are not being worked and have never been worked owing to their inaccessibility and even in areas which are being worked sometimes only a fraction of the full capacity of the forest is being utilized. As things stand, the annual income from bamboo to Mysore state could be estimated at about Rs. 60,000/- (1945) or perhaps more since bamboo is allowed to be removed, either free of cost or at nominal rates, in many portions of the rainy districts for the domestic use of local villagers. Owing to want of adequate demand bamboos were, and probably even now are, looked upon as an unwelcome adjunct to the forest crop in some places, and some foresters frown upon a dense bamboo crop as being responsible for shutting out tree growth and seedling regeneration of the valuable tree species over extensive forest areas. That this is a short sighted view time will probably show.

"The uses to which bamboo is put are innumerable and it may be said that there is no other plant which renders as many services to man as the bamboo" (P.N. Deogun). Owing to the combination of lightness and strength which bamboo possesses, the ease with which it can be propagated and the rapidity with which it grows it is eminently suited in every respect to serve the needs of man, and especially so of the poorer classes in India. Bamboo is therefore extensively employed in place of timber in India. In short there are few uses to which timber is put for which bamboo cannot be substituted. The uses to which bamboo could be put were considerably extended during the recent war, since the Burma campaign has shown that temporary bridges made entirely of bamboo are easily able to span fairly large streams and carry loaded lorries weighing 6 to 8 tons. Were it not for the readily available bamboo probably, the Indian army could not have progressed so rapidly as it did into the heart of Burma over difficult country cut up into hill and dale, scoured by perennial streams, and against a determined and tenacious foe. It is needless to enumerate the various uses to which bamboo is being put since these uses are generally well known, but there are some special aspects of the use of bamboo which could be touched upon.

In recent years bamboo has been used for making simple mathematical instruments—foot rules, set squares, etc. As a source of paper pulp bamboo is being used in India but to a limited extent, and in Mysore only *Dendrocalamus strictus* is employed for this purpose. There is great scope for the expansion of this industry in Mysore and the writer will not be far wrong in stating that, when *Bambusa arundinacea* (big bamboo) which is known also to be a good for paper pulp, will be utilized, the Mysore forests can easily provide raw material enough for at least a dozen paper mills of the size of the one now existing. The manufacture of artificial silk (rayon) from bamboo is yet a vast incompletely explored field, one which would have saved India large sums of money which are annually going out of the country on account of this commodity. Another possible use to which bamboo could be put is as a core for concrete in place of mild-steel rods. Lastly, mention must be made of the use of bamboo leaf as fodder to cattle, the young culms as a base for pickles and of bamboo seed as a source of food especially in some famine years. Bamboo seed is said to have saved the lives of thousands of helpless inhabitants of India from time to time. P.N. Deogun has given a list of conjoint seed years and areas of famine in various parts of India commencing with 1812.

(*To be continued*)

TIMBER FLOATING IN GODAVARI, INDRAVATI AND PRANHITA RIVERS

By R. M. SINGHAL, M.Sc., B.Sc., (EDIN.),

MADHYA PRADESH FOREST SERVICE

Everyone in timber trade or forestry is familiar with Chanda teak. The practice of scientific forestry here dates back to 1860 from the time of Col. Pearson and Cap. Forsyth—the first foresters to explore the forest wealth of Madhya Pradesh. Now Chanda district with its two divisions, North and South Chanda, contains the best forests of the State and provides the Government with 1/7th of its annual forest income.

The Southern ranges of South Chanda division, Pedigundam, Allapalli, Aheri-leased and Sironcha are situated in the angle formed by the Pranhita joining the Godavari and the latter then being joined by the Indravati. After receiving these two major rivers the Godavari has still to cover 275 miles before it joins the sea. It is this portion of its course that is largely used for floating timber. The Indravati and Pranhita are also used for floating but only for a short distance before they join the Godavari. The main market for the timber floated in these rivers is Rajmundry, 50 miles inwards from the mouth of the Godavari. The famous teak forests of the catchment areas of these rivers are situated in one of the least developed parts of the Indian Dominion. They are linked only in the North by the Sironcha-Chanda P.W.D. road—the southern half of which remains closed during the rains. The exploitation of these forests is limited due to their remoteness from market places and difficulty of communications. It would not be an exaggeration to say that, but for this floating enterprise, they would have remained valueless. From the map it can be seen that the quadrangle bounded by the Balarshah-Bezwada, Nagpur-Raipur and Raipur-Vizanagram lines is completely without major lines of communication.

Floating is started soon after the main strength of the monsoon has subsided *i.e.*, in the month of October. After December, the water in the Pranhita and Indravati is reduced to such low level that floating is no longer possible though it still continues in lower Godavari till March. The distance between the confluence of Godavari and Pranhita near Sironcha to Rajmundry is 288 miles and that from the confluence of Godavari and Indravati, 275 miles.

The following list shows the floating ghats :—

Name of river.	Name of ghat.	Distance from Rajmundry.
Indravati	Berarghat	299
	Rameshgudam	293
	Phatagudam	284
	Somanpalli	277
Pranhita	Wangapalli	348
	Muddunthora	322
	Karneli	309
	Tekra	298
Godavari	Sironcha	288
	Wardam	282
	Ankisa	279
	Somanur	276

Besides these, there are many ghats on the Godavari in Hyderabad State, Bastar state and the state of Madras from where timber and bamboos from the northern districts of Hyderabad, Bastar and Jeypur states and the Madras state are floated.

The timber floated is generally divided in two categories (*a*) teak and (*b*) non-teak. Teak forms about 90% of the entire quantity floated. Non-teak species include *Terminalia tomentosa*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Adina cordifolia*, the rarer species like *Gmelina arborea*, *Ougeinia dalbergioides* and bamboos.

Almost all sizes of teak down to poles 1½ feet in girth are carried but non-teak species below 2½ feet in girth are not generally transported. The logs are tied into rafts. 10 to 15 logs are tied together to make what is called an '*Achu*'. The *achus* should not exceed 9½ feet in width, but the length can be up to 20-25 feet. 10 to 12 *achus* are tied together to make a '*Jangilli*' and 10 to 15 '*Jangillis*' go to make a full consignment in charge of about 20 men. The number of logs rafted by one man is about 150. When they reach a barrier the *jangillis* are broken up again into *achus* and the *achus* are then passed safely through the barrier. Sometimes when the barrier is very difficult, the *achus* too, have to be broken up. They are regrouped into *achus* and *jangillis* after passing through the barrier. The *achus* are grouped in to a *jangilli* only when they have reached

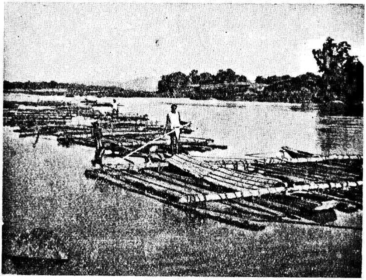


Fig. 1

Logs tied in rafts ready to move down on their long journey.

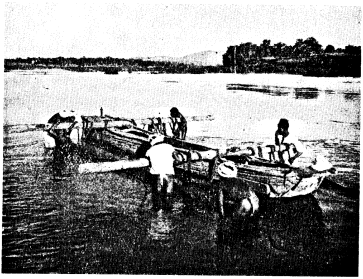


Fig. 2

Raftsmen tying teak logs to a boat.

lagudam—about 260 miles from Rajmundry—as the remaining portion of the course of the river is free of major barriers. Photograph 1 shows the method of rafting.

The bigger logs of teak not over 25 ft. in length and non-teak species are conveniently fashioned square or split before they are rafted. Teak logs, when other species are not to be floated by the proprietor, are tied together in rafts of 8 to 10 logs. Non-teak logs are mixed with teak logs. Generally 2 to 3 non-teak logs are tied together with 8 to 10 teak logs. Another method is to tie them with '*dongas*' (dug outs) made by hollowing tree trunks (Photo 2). Excess of non-teak logs are carted beyond the barriers to Tarlagudam and are taken in small motor, steam or row-boats. Bamboos are also tied into rafts often along with timber logs to give the logs more buoyancy. All this timber is brought to the ghats from the forests mainly by bullock-carts and dragged down the banks of the river to the edge of the water by buffaloes.

The following are the approximate figures of the quantity of timber floated down annually from South Chanda division alone :—

Species.	No. of logs.	Size (mid-girth) in inches.	Volume in Cubic feet.
Tectona grandis (logs)	1,15,000	30—80	6,66,500
,, ,,(poles)	18,300	18—29	
Pterocarpus marsupium (logs)	1,540	36—72	15,400
Dalbergia latifolia (logs)	530	,,	5,300
Termanalia tomentosa (logs)	4,100	,,	41,000
Adina cordifolia (logs)	460	48—72	6,900
Acacia catechu ,,	100	24—60	800
Gmelina arborea ,,	100	36—60	1,000
Ougeinia dalbergioides (logs)	150	36—60	1,500
Bamboos	30,000		
		Total cft.	7,38,400

The rafts have to pass through many barriers in the rivers before they reach Tarlagudam, the chief of which are Gadraigattu, Kandalaparupu and Gazingattu. Some of these barriers are very dangerous and the rafts have to be broken up to pass through them and regrouped later. The journey from the ghat in the forest down to Rajmundry takes 2 to 4 months, depending on the depth of water in the river and the speed of the current. About 15-20% loss in non-teak kinds and 5% in teak is considered as an average loss of timber on the way due to sinking, stranding and drifting. Timber is checked up and passed in Madhya Pradesh at Sironcha and in Madras state at Polavaram.

To take the rafts to Rajmundry, labour is recruited from the Dhiwars of Wadligudam (Andhra) in batches of 25 to 30 men, and they are paid a lump sum amount of Rs. 100/- to 250/- each, for the entire transport *i.e.*, about -/8/- per cft. Besides this, they have to be provided with rations for the period of their stay away from their homes and another and -/-/6 a day for their tobacco and chillies. Each cooly takes about 800 to 1,000 cft. of timber with him. Besides these, there are supervision and clerical expenses to be paid. In toto the transport costs from -/14/- to 1/4/- per cft. from the forest to the market at Rajmundry.

The cost of carting timber from the forest to the ghat varies from 6 to 13 pies per cft. per mile depending upon the availability of labour and the condition of the roads. It is the dragging down from the edge of the river—which is much higher than the water level—to the the water side that takes most money. This costs -/1/6 to -/4/- per cft. depending upon the size of the log, the dragging distance and the degree of the slope. Ropes required to tie the rafts are purchased at Bezwada and have to be brought to the ghats. These are cocoanut fibre ropes and can serve only once, because they become too feeble to be used again.

The price of timber paid by the contractors in Chanda district is about 2/-/- per cft. standing for teak, and about 1/4/- for the other species. The selling prices at Rajmundry for teak varies from Rs. 4/- to Rs. 12/- per cft. The margin of profit is always greater for big sized timber, but about 60% of the timber exported is of small sizes.

At Rajmundry the timber is consumed locally in the districts of Krishna and Guntur. Part of it is shipped to Waltair and from there to Vizagapattam for ship building. It is also sent to other parts of the presidency.

The construction of Rampadsagar dam on the Godavari would render 400 miles of its lower course navigable. Another plan—the famous Wainganga project—when completed will allow big boats to reach the heart of the forest. The value of these remote forest areas at present is entirely due to this floating enterprise taken up by the Rajmundry timber contractors. The facilities of the cheap water-transport will, we hope, increase their value much more and make an intense management of these valuable forests possible.

ON A BOTANICAL TRIP TO THE PARBATTI VALLEY.

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Recently in June 1950 we had the good fortune to visit the beautiful valley of the river Parbatti (a tributary of the Beas), which is a part of the well-known and picturesque Kulu valley. The object of this article is to record some interesting observations on the vegetation and plants of this area, made by us.

The river Parbatti joins the Beas at Bhuintar, a small town 34 miles north of Mandi in Himachal Pradesh. Unfortunately the approach to Bhuintar is by a very round about route, *viz.* via Amritsar, Pathankot, Nagrota, Palampur and Mandi. A new motor road which will connect Simla with Aut, a place 8 miles from Bhuintar, is under construction. The locomotive goes up to Nagrota, from where good motorable road leads to Mandi by Jogendranagar; and then along the Beas via Bhuintar and Kulu straight to Manali. The road from Mandi to Bhuintar is motorable, but this can be done only by an experienced and adventure-loving driver.

Our first camp was at Nagrota, from which we visited the Pathear hill range, one of the most modest among the lofty Dhauladhar hills. The elevation of the ridge is 4,000 ft. It is covered with Chir-pine. The undergrowth is mostly *Carissa opaca* Stapf and *Myrsine africana* Linn. Occasionally we saw *Fragaria indica* Andr., *Lepidagathis cuspidata* Nees and *Rumex hastatus* Don. The entire ground is covered with chir (*Pinus longifolia* Roxb.) needles. At the top of the ridge there is an old fort, believed to be some 1,000 years old. At this elevation (4,000 ft.) the presence of a well inside the fort was a noteworthy thing. There is also a temple close by. Standing on this ridge one can see just on the north and north-east the vast open Kangra valley, through which we were told our buses have to pass on their way to Mandi. On the south and south-east the Siwaliks and the river Beas were in sight at a considerable distance. On the west the town of Dharamsala could be seen. The chir forests of Nagrota are largely tapped for resin.

Extensive tea estates with shade trees consisting of *Albizzia odoratissima* Benth. and *A. stipulata* Boivin. were seen. The motor road from Nagrota to Mandi is good. We noted *Celtis australis* Linn., *Mangifera indica* Linn., *Cedrela toona* Roxb., *Terminalia arjuna* Bedd., *Sapindus mukorossi* Gaertn., *Grewia haineseana* Hole, and *Xylosma longifolium* Clos. to be the more common roadside trees. After halting for the night at Mandi, we left for Bhuintar the next day. The narrow road, the overhanging rocks, the roaring noise of the fast flowing Beas some 500 ft. below on the right, and occasional warnings of "Cautious Driving" made the journey more painful than pleasant. Owing to the gate timings we had to wait at Aut for a few minutes. This is a small town. There are some good shops of general merchandise and some edible commodities.

The camping place at Bhuintar is an excellent piece of level ground, stated to be used also as an emergency landing ground for aeroplanes. It is surrounded on all sides by lofty mountains, the southern and south-eastern slopes of which are almost barren. At Bhuintar we collected only few plants in their flowering stage, including an *Indigofera* which, in all probability, is *Indigofera silvestri* Pamp., a Chinese plant only collected once before from an adjacent area by Parker, but not hitherto mentioned in any work on Indian flora. Here we also saw the riverain forest of *Alnus nitida* Endl. Among the cultivated ornamental plants mention should be made of the beautiful tendril climber *Passiflora coerulea* Linn., whose clock shaped prominent flowers attracted much attention.

The river Parbatti is about 80 miles long, but the valley is inhabited only upto about 40 miles beyond Bhuintar. There are forest Rest houses at Bhuintar, Jari, Kasol and Pulga. The valley is narrow, running S.W.—N.E. from Bhuintar to Manikern, and N.W.—S.E. from Manikern to Pulga. The bridle path runs from Bhuintar to Manikern (the famous hot water and sulphur springs) along the left bank of the river and from Manikern onwards on the right bank. It was interesting to see rounded blocks of the stones in the rocks along the bridle path. This fact along with the presence of alluvial soil up to more or less 500 ft. above the present level of the river clearly shows that the Parbatti was at sometime flowing high up and it has gradually cut its bed down deeper and deeper, resulting in the present narrow valley.

Fig. 1

A Deodar forest at Jari.

(Photo by R.C.B.)

Fig. 2

A patch of the fern *Pteridium aquilinum* at Kasol.

(Photo by R.C.B.)

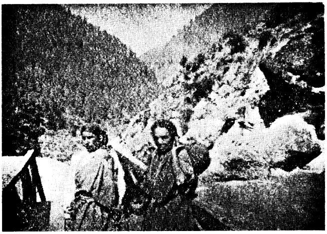


Fig 3

Between Manikern and Pulga : (Looking west) Barren slopes on the right bank, and densely clothed slopes on the left bank of the river Parbatti.

(Photo by S.K.J.)

Fig. 4

Swanjni maidan: Snow-clad Peaks in view on the immediate north-east.

(Photo—Vashisht)

All along the right bank the precipitous scarp slopes are almost barren or occasionally chir, *kail* (Pinus excelsa Wall) and deodar or any one of them alone are present on the scree deposits in the scattered depressions and on fresh alluvium along the bank. On the left bank too, up to Manikern the slopes are scarp, but as they have a northern aspect they have much more vegetation than the right bank. Beyond Manikern the direction of the valley changes and consequently the right bank continues to have rocks of the scarp slope with south-west aspect, while the left bank has gentle dip slopes with shaded and cool north-eastern aspect, and consequently they bear dense kail, deodar (*Cedrus deodara* Loud.) and fir (*Abies pindrow* Spaak.) or any of them, or broad leaved species depending upon the elevation and the type of rock.

The general features of the flora of some of the spots visited are described below.

On the way from Bhuintar to Jari the hills on both sides of the river have only sparse vegetation. The chief reasons seem to be the precipitous slope of the ground, heavy grazing and annual fires. *Roylea calycina* Brig., *Berberis* species, *Plectranthus rugosus* Wall., *Olea cuspidata* Wall., *Salvia moorcroftiana* Wall., *Sageretia oppositifolia* Brongn. and *Sedum adenotrichum* Wall. are common along and near the bridle path. Wild *Punica granatum* L., and *Zanthoxylum alatum* Roxb. are also fairly common. *Ulmus wallichiana* Planch., *Populus ciliata* Wall. are occasionally met with. On fresh alluvium along river banks *Alnus nitida* Endl. is found.

Jari is a small village with a few dozen houses. There are some shops dealing in general merchandise and a civil hospital. The camping ground is in dense deodar forest. From this place we visited the Gagyani Dhar (7,100 ft.). The forests here consist of pure deodar, chiefly on ridges and spurs (Fig. 1). At one place (Oridhar) an old deodar tree which is 32 ft. in girth is a noteworthy object. A portion of its trunk has been recently burnt. Spruce (*Picea morinda* Link.) is occasionally met with in depressions, and kail on freshly exposed soils. In some damper places formation of *Iris melisi* Fost. were noticeable. The root system of Iris spreads horizontally and covers the ground creating unfavourable conditions for deodar./ In some depressions broad leaved species such as *Spirea lindleyana* Wall., *Viburnum foetens* Dcne., *Rhamnus virgata* Roxb., *Rosa moschata* Mill., and *Indigofera dosua* Ham. were seen. The ground flora consisted chiefly of species of *Androsace Plantago*, *Fragaria*, *Ranunculus*, *Oxalis*, *Viola*, *Galium*, *Phytolacca* and *Delphinium*. *Salvia glutinosa* L., though not in flower, was met with almost everywhere. There is a paucity of epiphytes.

Mention may be made of the plants cultivated in the Jari forest rest-house, because the gardens of this resthouse appear well cared for. The ornamental plants found consisted of Cannas, *Calendula*, *Iris*, *Tagetes*, *Helianthus*, lily and others. The fruit trees found are apple, apricot, plums, cherry, etc. Two large graceful trees of *Populus nigra* L. with their fastigiate branches are the first to welcome the visitor.

On the way from Jari to Kasol we came across chiefly chir, at places mixed or even dominated by *Kail* and deodar, the latter being the case on scree deposits or on alluvium. The undergrowth and the ground flora consisted chiefly of species of *Jasminum*, *Berberis*, *Rubus*, *Cotoneaster*, *Salvia* and *Spirea*. Here we found a few trees of *Rhododendron arboreum* Sm. for the first time just by the side of the bridle path. We noticed extensive chir forests on quartzite rock of the right bank hills; and deodar and others on the left bank on mica-schist and alluvial soils; higher up chir is found on quartzite.

At about 2½ miles from Jari there is a swampy area from which we collected *Alisma plantago* L., *Acorus calamus* L., *Houttuynia cordata* Thunb., *Juncus bufonius* L. and others.

Kasol camping ground is open just at the level of the river Parbatti. At Kasol we find one of the best deodar forests. On the spurs chir is also present. In depressions broad-leaved species such as *Cedrela serrata* Royle, *Cornus macrophylla* Wall., *Alangium chinense* Rech., *Rhus punjabensis* Stew., *Rhododendron arboreum* Sm., *Xolisma ovalifolia* Rehd. (*Pieris ovalifolia*, Don.) and *Spirea lindleyana* Wall. are found.

The undergrowth consists mainly of species of *Sarcococca*, *Berberis*, *Deutzia* and *Pteris*, etc. Among the climbers we saw species of *Dioscorea*, *Smilax*, *Rubia*, *Ichnocarpus* and *Vitis*. The herbaceous ground flora was quite rich; to name a few, the more common ones are —*Fragaria*, *Mazus*, *Cerastium*, *Bergenia*, *Geranium* and *Salvia*. Patches of the fern *Pteridium aquilinum*, (L.) Kuhn. (*Pteris aquilina* L.) are very common in the moister, shaded places (Fig 2). Near the nursery a patch of *Arundinaria falcata* Nees was prominent.

On the way from Kasol to Pulga at Manikern, 2½ miles from Kasol, mention has to be made of the existence of hot water sulphur springs. These are said to be the hottest springs

in the world. People associate their origin with Lord Shiva and Parbatti. A small town with about 50 houses and a few temples has developed at Manikern. Just before Manikern we had crossed the Parbatti and took to the right bank.

Close to the Manikern there are some silver mines, and the Parbatti valley is sometimes called "Rupi" valley. The silver is, however, in a brittle form and its conversion into malleable form is uneconomic.

After Manikern, the change in the aspect of the slopes is well marked. Along the bridle path (now the right bank of the river) the scarp slopes with south-west aspect are almost devoid of vegetation in the upper portions, but the slopes at the river level are fertile due to alluvial deposits and covered with *kail* and spruce. The slopes on the left bank of the river are densely covered with *kail*, deodar or spruce. Looking west, one finds almost bare rocks on the right bank, but densely clothed slopes on the left (Fig. 3).

On the left bank, at one spot, the existence of a large patch of broad-leaved species in between the dense *kail* and deodar growth is a striking feature. This is believed to have been caused by a glacial moraine of the recent past. The trees found here were of *Juglans regia* Linn., *Ulmus* sp., *Acer* sp., *Corylus colurna* L., *Aesculus indica* Colebr., *Celtis* sp. etc.

The common plants along the path were of the species of *Berberis*, *Spirea*, *Amphicome*, *Rosa*, *Cnicus*, *Cotoneaster*, *Fragaria*, *Hippophe*, *Picrasma*, *Desmodium* and others.

At about 8 miles from Kasol we crossed the Parbatti and took the left bank again. The bridle path on the right bank, which we left, goes ahead to Toshnal. The slopes on the left bank of the river at this place are cool and shaded, and densely covered with ground flora. Among the species collected the notable ones are of *Fragaria*, *Androsace*, *Dicliptera*, *Galium*, *Geranium*, *Ranunculus* and some ground orchids. *Alnus nitida* Endl., *Aesculus indica* Colebr., *Populus ciliata* Wall. and *kail* are inhabiting the fresh alluvials. We crossed some fast flowing, silvery, streams with their banks covered with dense growth of ferns, liverworts, and other plants. At one spot *Lilium giganteum* Wall., a very large-leaved herb, was growing conspicuously.

Pulga is a lovely spot (7,300 ft.). The camping place is an uneven piece of ground situated under deodar groves. We visited Swanjni maidan, Bhandag Thach, and still higher points with elevations up to about 13,500 ft. The forests here are dominated by high level blue pine, which is replaced higher up by spruce and silver-fir (*Abies pindrow* Spaak.). In some places snow-damaged trees are a common sight. On the way to *Swanjni maidan* we saw species of *Indigofera*, *Salvia*, *Viola*, *Angelica*, *Dipsacus*, *Anemone*, *Thymus*, *Gentiana*, *Trillium*, *Caltha*, *Fragaria*, *Podophyllum*, *Clematis*, *Rosa*, *Wikstroemia*, some orchids and others. *Podophyllum* is an important medicinal plant found here, which is being exported by local traders to America. In one of the old nurseries experiments were in progress to study the growth of exotic species such as *Larix europea* D.C., *L. leptolepis* Endl. and *Pseudotsuga taxifolia* Britton. It was observed that the growth of exotics was not good enough for replacing the fir. The Swanjni maidan is a picturesque spot of almost level ground matted with *Anemone*. Lofty snow-clad mountains stand in grandeur to its immediate north-east (Fig. 4). At Thach *Anemone* and *Potentilla* were very common, lending a characteristic feature to the ground flora.

Above Thach we collected typical alpine plants such as *Rhododendrons*, *Sibbaldias*, *Potentillas*, *Primulas*, *Trollius*, *Gentianas*, *Betula Salix*, etc. Hill climbing was no doubt trying at these altitudes, but the sight of the above species which we saw for the first time in our life encouraged us at every step.

From an elevation of 10,000 ft. and upwards we noted that arboreal forms were gradually being replaced by shrubby forms and higher still by herbs. At an elevation of about 12,000 ft. *Rhododendron campanulatum* Sm., *Salix* sp., *Betula utilis* Don, and *Pyrus aucuparia* Gaertn. were the only arboreal forms found. The bushy branches of *Rhododendron campanulatum* Sm. are so intertwined in places as to form impenetrable thickets. The last of the representatives of the vegetation were *Primulas*, *Gentianas*, *Sibbaldia*, *Cassiope*, *Gaultheria* and some other herbs not in flower at the time. *Sibbaldia purpurea* Royle was noted straggling up to about 13,500 ft. where it practically touched the limit of the snow line.

The following list of plants collected from the Parbatti valley though by no means a complete flora of this area, yet suffices to show the main features of the vegetation. The plants collected at Nagrota have also been included.

The total number of species on the list is 245 (belonging to 189 genera and 82 families), of which 48 species, which are not mentioned in Collett's Flora Simlensis, are marked with an asterisk.*

I. Flowering Plants.

1. **Acorus calamus** Linn. (Araceae).
An aromatic erect herb. Leaves resemble those of Iris. Flowers yellow-green. —On way to Pulga.

2. **Adhatoda vasica** Nees. (Acanthaceae).
A glabrous shrub 4-8 ft. Flowers gathered in spikes and dotted with pink; bracts leaf-like. —Bhuintar.

3. **Aesculus indica** Colebr. (Sapindaceae).
A tree with white or pale flowers. —Pulga

4. **Ainsliaea aptera** D C. (Compositae) An erect herb. Achenes hairy. —Pulga.

5. **Ajuga parviflora** Benth. (Labiatae).
A soft hairy herb. Flowers hardly 1/4 in. long, blue. —Jari and on way to Pulga.

6. **Alangium chinensis** (Lour.) Rehd.-*Marlea begoniefolia* Roxb. (Alangiaceae).
A small tree with white flowers. —Kasol.

7. **Alisma plantago** Linn. (Alismaceae).
An aquatic herb; leave entire. Flowers small in a pyramidal panicle, pale, pink with yellowish claws.—Jari and Kasol in marshy places.

8. **Allium govanianum** Wall. (Liliaceae).
Bulbs clustered. Stem base covered with leaf-sheath. Leaves flat. Flowering stem angled. Flowers white. —Pulga.

9. **Alnus nitida** Endl. (Betulaceae). A tree.
Branchlets pubescent. Leaves long, pointed, more or less distinctly toothed. Male catkin 2-4 in. erect. Stamens 4. Bracts of cone thick, woody, persistent. —Bhuintar.

10. ***Amaranthus spinosus** Linn. (Amaranthaceae)
An erect spinous herb, glabrous. Flowers many, minute, in dense axillary clusters or in terminal spikes upto 5,000 ft. —Bhuintar.

11. **Amphicome arguta** Lindl. (Bignoniaceae).
A glabrous erect herb. Flowers pink, in erect or drooping racemes. —On way to Pulga.

12. **Andrachne cordifolia** Muell. (Euphorbiaceae).
A small shrub. Flowers 1/6 in. green, on slender axillary stalks; male clustered; female solitary. 5,000—8,000 ft. —Jari.

13. **Androsace lanuginosa** Wall. (Primulaceae).
A herb covered with silky hairs. Flowers pale or dark purple. —Jari, 7,000 ft.

14. **Androsace rotundifolia** Hardw. (Primulaceae)
A hairy herb. Flowers pale or dark purple, tinged with blue. —On way to Jari.

15. **Anemone obtusiloba** D.Don (Ranunculaceae).
A tufted hairy herb. Radical leaves 3-parted, crenate. Flowers 1.5-2 in. in diam., white or tinged with blue near the base. —On way to Rorich Sar (Pulga).

16. **Anemone rivularis** Buch-Ham. (Ranunculaceae).
A pubescent herb. Flowers 1-1.5 in, white, lower surface tinged with purple. —Pulga.

17. **Aquilegia pubiflora** Wall. (Ranunculaceae).
A thin hairy or pubescent herb. Flowers violet or pale purple —Kasol and Pulga.

18. **Argyrolobium flaccidum** J. & S. (Papilionatae)
A small erect shrub densely covered with short hairs. Flowers yellow. —Bhuintar

19. **Arisaema helleborifolium** Bl. (Araceae).
Leaves pedately compound, leaflets ovate-lanceolate. Spathe green, finely ribbed. Male and female flowers on the same plant. —Pulga.

20. **Arisaema wallichianum** Hook.f. (Araceae).
The cobra or snake plant. A herb with a single digitate leaf. —Pulga.

21. **Asparagus filicinus** Buch-Ham. (Liliaceae).
An erect, tall, unarmed shrub. Flowers white, single or in pairs, fragrant. —Pulga.

22. ***Berberis edgworthiana** C.K. Selm. (Berberidaceae).

A low rigid shrub. Flowers yellow. Berries red. —Pulga.

23. **Berberis lycium** Royle. (Berberidaceae).

A spiny shrub with pale grey bark. Flowers pale yellow in simple, short racemes. —Nagrota.

24. **Bergenia ligulata** (Wall.) Engl.-*Saxifraga ciliata* Royle (Saxifragaceae).

A herb with fleshy leaves and pinkish-white flowers. —Kasol.

25. **Bergenia stracheyi** (Hook.f.) Engl.-*Saxifraga stracheyi* Hook.f. (Saxifragaceae).

A herb with white, pink or purple flowers 1·25 in. in diam. —Pulga 10,000-11,000 ft.

26. **Betula utilis** D.Don. (Betulaceae).

A tree, with smooth papery bark, peeling off in thin sheets. —Pulga, 11,500 ft.

27. **Caesalpinia sepiaria** Roxb. (Caesalpiniaceae).

A prickly climbing shrub. Flowers yellow in erect racemes. —Kasol.

28. **Calamintha clinopodium** Benth. (Labiatae).

Erect hairy herb; flowers purple, in whorls, surrounded by an involucre of bracts. —Bhuintar.

29. **Calamintha umbrosa** Benth. (Labiatae).

Erect hairy herb. Flowers purple, in few flowered whorls, the latter without involucre of bracts. —Bhuintar and Jari.

30. **Calanthe tricarinata** Lindl. (Orchidaceae).

Herb. Flowers $\frac{3}{4}$ in. across, green outside, edged with white, pale, yellow-green inside. On way to Pulga and Pulga.

31. **Caltha palustris** Linn. (Ranunculaceae)

A glabrous herb up to 18 in. Leaves reniform, shining. Flowers regular yellow, 1-2 in. in diam. terminal. 8,000-10,000 ft. on marshy ground. —Pulga.

32. **Campanula ramulosa** Wall.-*Campanula colorata* Wall. (Campanulaceae).

A rough tomentose herb. Flowers $\frac{1}{4}$-$\frac{1}{2}$ in. long, pale-lilac. —Jari and Pulga.

33. **Capsella bursa-pastoris** Moench. (Cruciferae).

A herb, more or less covered with forked hairs. Flowers white, small, in racemes. Pod triangular. —Pulga.

34. ***Cardamine impatiens** Linn. (Cruciferae).

A small glabrous herb. Flowers small, white. —Pulga.

35. **Cardamine macrophylla** Willd. (Cruciferae).

An erect herb upto 2.5 ft. high, robust. Flowers white or tinged with violet. Pod linear long. —Pulga 8,000–9,000 ft. and Khirganga.

36. **Carduus nutans** Linn. (Compositae).

An erect robust rough herb. Flowers crimson red. —Bhuintar.

37. ***Carissa opaca** Stapf.=*C. spinarum* Auct. (Apocynaceae).

A small thorny, evergreen shrub with white flowers. —Nagrota.

38. ***Cassia laevigata** Willd. (Caesalpiniaceae).

A large shrub with yellow flowers. —Nagrota.

39. **Cassiope fastigiata** D.Don. (Ericaceae).

A small shrub. Flowers axillary, white, solitary, or in clusters. —Pulga., 12,000 ft.

40. **Centella asiatica** (L.) Urb.-*Hydrocotyle asiatica* Linn. (Umbelliferae).

A herb rooting at the nodes. Fruits laterally compressed. —Nagrota.

41. **Cephalanthera ensifolia** Rich. (Orchidaceae).

A herb almost or quite glabrous. Flowers white, nearly erect. —Pulga.

42. **Cerastium vulgatum** Linn. (Caryophyllaceae).

A pubescent viscid herb. Flowers white in terminal forked cymes. —Pulga.

43. ***Chrysanthemum indicum** D C. (Compositae).

A small herb with very small flowers. —Bhuintar.

44. **Cissampelos pareira** Linn. (Menispermaceae).

A twining shrub, tomentose. Male flowers in cymes and female in racemes, small —Nagrota.

45. ***Clematis graveolens** Lindl. (Ranunculaceae).

A Slender climber. Flower 2 in. in diam. pale yellow, with heavy odour. —Bhuintar.

46. **Clematis montana** *Buch—Ham.* (Ranunculaceae).

A glabrous or pubescent climber. Flowers white, 2—3 in. in diam, axillary. —Pulga, 10,000 ft.

47. **Cnicus argyracanthus** D C. (Compositae).

A herb with robust stem. Flowers pale-yellow or white in globose heads. —Bhuintar.

48. **Coriandrum sativum** Linn. (Umbelliferae).

A glabrous herb. Flowers in compound umbels, white.—"The common coriander." —Pulga.

49. **Coriaria nepalensis** Wall. (Coriariaceae).

A glabrous shrub. Bark red. Flowers small green, in lateral clustered racemes. —Kasol.

50. **Cornus macrophylla** Wall. (Cornaceae).

A large tree. Cymes terminal, compound; petals hairy outside. Drupe pubescent, globose, 1/5 in. in diam. —Kasol.

51. ***Corydalis cachemeriana** Royle. (Fumariceae).

A small herb with 3-6 partite leaves. Flowers blue 0.5-1 in. long. —Pulga 12,500ft.

52. **Corydalis govaniana** Wall. (Fumariaceae)

An erect herb up to 18 in. Flowers bright yellow, 1 in. long, spur conical. —Pulga 8,000—10,000 ft.

53. **Cotoneaster bacillaris** Wall. (Rosaceae)

A large shrub. Flowers white in loosely branched cymes. —Pulga 8000 ft.

54. **Cotoneaster microphylla** Wall. (Rosaceae)

A dwarf dense shrub. Flowers white, usually solitary. —On way to Jari and Kasol.

55. **Crassula *indica*** Dec. (Crassulaceae).

A glabrous fleshy herb. Flowers dull pink in a long terminal panicle. —Kasol.

56. **Cucubalus baccifers** Linn. (Caryophyllaceae).

A rambling, pubescent herb. Flowers white, *tinged with yellow-green. —On way to* Pulga.

57. **Cyathocline lyrata** Cass. (Compositae).

An erect, pubescent, sweet scented herb. Flowers rose-purple —Nagrota.

58. **Cynanchum vincetoxicum** Pers. (Asclepiadaceae).

An erect shrub with small yellow flowers. —Pulga.

59. **Cynodon dactylon** Pers. (Gramineae).

Culms prostrate, creeping. Spikes 2—5, digitately spreading. Spikelets awnless and along one side only. —Common.

60. **Cynoglossum zeylanicum** (Vahl) Thunb.-*C. furcatum* Wall. (Boraginaceae)

Erect pubescent herb with small blue flowers. —Pulga.

61. **Datura stramonium** Linn. (Solanaceae).

A coarse herb with white flowers. Not very common. —Manikern & Pulga.

62. **Delphinium denudatum** Wall. (Ranunculaceae).

A herb upto 3 ft. high, glabrous or nearly so. Flowers blue. —Jari & Pulga 5,000-10,000 ft.

63. **Desmodium tiliaefolium** Don. (Papilionatae).

A tall erect shrub with pale pink flowers. —On way to Pulga.

64. **Deutzia corymbosa** R.Br. (Saxifragaceae).

A shrub with thin bark, peeling off. Flowers white in a few corymbose panicles. —Pulga, 8,000—10,000 ft.

65. **Deutzia staminea** R.Br. (Saxifragaceae).
An erect shrub. Leaves tomentose beneath. Flowers ¾ in. diam. in numerous panicles. —Pulga.

66. **Dichanthium annulatum** Stapf. (Gramineae).
Spikelets imbricate; sessile, except the lowest one or two, awned. —Bhuintar.

67. **Dichrocephala latifolia** DC. (Compositae).
Pubescent or roughly hairy herb. Flowers minute, in heads. —Nagrota.

68. ***Dicliptera roxburghiana** Nees. (Acanthaceae).
A herb up to 3 ft. high. Flowers pink. —Nagrota and Kasol.

69. **Dioscorea deltoidea** Wall. (Dioscoreaceae).
A glabrous climber. Flowers in small distant clusters. —Almost everywhere.

70. **Erigeron linifolius** Willd. (Compositae).
A herb more or less hairy. Ray-florets pale purple or white. —Bhuintar.

71. **Erysimum hieraciifolium** Linn. (Cruciferae).
An erect herb with stellate hairs. Flowers orange yellow. —Pulga.

72. **Euonymus lacerus** Ham. (Celastraceae).
A shrub or small tree with small white flowers. —Pulga.

73. **Euphorbia helioscopia** Linn. (Euphorbiaceae).
A glabrous herb. Flowers in umbels; involucral glands not bordered. —Bhuintar.

74. **E. hypericifolia** Linn. (Euphorbiaceae)
A glabrous or slightly pubescent herb; flowers in terminal or axillary cymes; involucral glands with a petal like border.—Bhuintar.

75. **Fragaria indica** Andr. (Rosaceae)
A softly silky herb with yellow flowers ½-1 in. diam. —Nagrota and Bhuintar.

76. **F. vesca** Linn. (Rosaceae).
A softly silky herb with white flowers about 1 in. in diam. —Pulga.

77. **Fritillaria roylei** Hook. (Liliaceae).
A glabrous bulbous herb. Flowers yellow-green, chequered with purple. —On way to Rorich-sar, Pulga.

78. **Galinsoga parviflora** Cav. (Compositeae).
An erect herb with yellow disk-florets. —Kasol.

79. **Galium triflorum** Michx. (Rubiaceae).
A glabrous herb with flowers white or tinged with yellow. —Pulga.

80. ***Gaultheria trichophylla** Royle (Ericaceae).
A small prostrate herb. Flowers campanulate, red or nearly white. —Pulga.

81. **Gentiana argentia** Royle. (Gentianaceae).
Stem leafy; leaves silvery shining, narrowly lanceolate.
Flowers sessile, blue, ½ in. in diam., crowded in terminal heads. —Kasol.

82. ***Gentiana carinata** Griseb. (Gentianaceae).
A small herb, flowers deep blue, clustered. —Pulga, 13,000.

83. **Geranium nepalense** Sweet. (Geraniaceae).
A pubescent or softly hairy herb. Flowers pale purple, small. —Jari.

84. **G. robertianum** Linn. (Geraniaceae).
A softly hairy herb. Flowers red-pink streaked with white, ½ in. diam. —Pulga.

85. **Gerbera lanuginosa** Benth. (Compositae).
A herb with lanceolate leaves. Flowers often tinged with pink. —Kasol.

86. **Gnaphalium luteo-album** Linn. (Compositae).
An erect herb, more or less softly woolly. Flowers bright yellow. —Bhuintar.

87. ***Gnaphalium thomsoni** Hook. f. (Compositae).
A softly cottony herb. —Bhuintar.

88. **Gypsophila cerastioides** Don. (Caryophyllaceae).

A pubescent herb. Flowers small, numerous, white streaked with purple. —Pulga.

89. **Hackelia glochidiata** (Wall.) Brand. *Paracaryum glochidiatum* Benth. (Boraginaceae).

A pubescent herb with pale blue flowers. —Pulga.

90. **Hieracium vulgatum** Koch. (Compositae).

A hairy herb with yellow flowers in heads on a glandular hairy stalk. —Pulga.

91. **Hippophae salicifolia** Don. (Elaeagnaceae).

A large thorny deciduous shrub. Male flowers in axillary clusters on the old wood; female flowers axillary, solitary, pedicelled. —On way to Pulga.

92. **Houttuynia cordata** Thunb. (Piperaceae).

A pubescent herb. Spikes with an involucre of large spreading white (petal like) bracts. In marshy places. —On way to Pulga.

93. **Hypericum cernuum** Roxb. (Hypericineae).

A shrub with yellow flowers, 2 in. in diam., in terminal cymes. —Jari.

94. **H. perforatum** Linn. (Hypericineae).

A small herb with small yellow flowers. —Jari.

95. ***Impatiens bicolor** Royle (Balsaminaceae).

A succulent herb with reddish veined, yellow flowers. —Nagrota

96. **Indigofera dosua** Ham. (Papilionatae).

A tomentose shrub with bright red flowers. —On way to Jari.

97. **I. gerardiana** Wall. (Papilionatae).

A silvery pubescent or tomentose shrub with pale red or purple flowers. —Pulga.

98. ***I. silvestri** Pamp. (Papilionateae)

A small shrub. Stems and branches pubescent. Leaves 1 in. long, leaflets 5-7, rusty brown below. Flowers ¼ in. long in axillary racemes. Corolla pale purple —Bhuintar.

99. ***Iris milesii** Foster (Iridaceae).

A herb with equitant leaves. Flowers bluish-purple. —Jari.

100. **I. nepalensis** D. Don. (Iridaceae).

A fleshy herb. Flowers violet with a yellow ridge-like crest along the centre. —Pulga, 11,500 ft.

101. **Jasminum humile** Linn. (Jasminaceae).

An erect shrub. Flowers yellow. —Pulga.

102. **J. officinale** Linn. (Jasminaceae).

A climber or semi-erect shrub. Flowers white. —Jari.

103. **Juglans regia** Linn. (Juglandaceae). "Walnut."

A large, aromatic deciduous tree with velvety shooots. —At various places.

104. **Juncus bufonius** Linn. (Juncaceae).

A pale-green herb with few leaves. Flowers solitary or clustered. —In a marshy area, on way to Kasol.

105. **Kickxia ramosissima** (Wall.) Janchen.—*Linaria ramosissima* Wall. (Scrophulariaceae).

A glabrous herb. Flowers yellow with a straight spur. —Bhuintar.

106. **Lactuca dissecta** Don. (Compositae).

A glabrous herb. Heads many, corymbose, pale-blue. —Bhuintar.

107. **Lamium album** Linn. (Labiatae).

A decumbent herb. Flowers white or plac-pink. —Pulga.

108. **Lathyrus luteus** Baker. (Papilionatae).

A perennial herb with bright yellow flowers. —Pulga.

109. ***Lepidagathis cuspidata** Nees. (Acanthaceae).

An erect undershrub. Flowers white, streaked with purple. —Nagrota.

110. **Lespedeza sericea** Miq. (Papilionatae).

A densely pubescent shrub with pale yellow flowers. —Nagrota.

111. **Leucas lanata** Benth. (Labiatae).

A white wooly tomentose herb. Flowers small, ½ in. long, numerous, in small axillary whorls. —Nagrota.

112. **Ligustrum compactum** Hook.f. and Th. (Apocynaceae).

A small tree with white flowers. —Jari.

113. **Lilium giganteum** Wall. (Liliaceae).

A tall herb up to 12 ft. high. Leaves cordate. Flowers 4-6 in. white. —Pulga.

114. **L. polyphyllum** Don. (Liliaceae).

Stem 1-3 ft. Flowers greenish white, with purple dots inside. —Pulga.

115. **Lloydia serotina** Reichb. (Liliaceae).

A small glabrôus herb. Perianth bell-shaped white, with violet veins. —Pulga.

116. **Lolium temulentum** Linn. (Gramineae).

Spikelets green or tinged with purple, flattened, singly sessile in notch-like grooves, alternate on the rhachis of a simple spike. —Jari.

117. **Lonicera angustifolia** Wall. (Caprifoliaceae).

An erect shrub. Flowers white tinged with pink, pubescent. —Pulga.

118. **L. hispida** Pall. (Caprifoliaceae).

An erect shrub. Flowers ¾ in. long, pale-green, often hairy. —Pulga.

119. **L. orientalis** Lamk. (Caprifoliaceae).

An erect almost glabrous shrub. Flowers pink, ½ in. long. —Pulga.

120. **L. quinquelocularis** Hardw. (Caprifoliaceae).

An erect pubescent shrub. Flowers yellow, hairy. —Jari and Pulga.

121. **Lotus corniculatus** Linn. (Papilionatae).

A perennial glabrous herb with yellow (or crimson-streaked) flowers. —Bhuintar.

122. **Lysimachia pyramidalis** Wall. (Primulaceae).

A glabrous herb. Flowers pale pink, in terminal cymes. —Nagrota.

123. **Malva parviflora** Linn. (Malvaceae).

A pubescent spreading herb; flowers small, pale pink, petals hardly longer than the calyx. —On way to Khir-ganga.

124. **M.rotundifolia** Linn. (Malvaceae).

A stellately pubescent herb, flowers pale lilac. —Khirganga.

125. **Mazus rugosus** Lour. (Scrophulariaceae).

A tufted herb. Flowers pale-blue or white streaked with blue, upper lip darker. —All over above Bhuintar.

126. **Medicago lupulina** Linn. (Papilionatae).

An annual pubescent herb with bright yellow flowers. —Jari.

127. **Meliosma dilleniaefolia** Wall. (Sabiaceae).

A small tree with rusty pubescent leaves. Flowers in panicles. —Kasol.

128. **Micromeria biflora** Benth. (Labiatae).

An aromatic usually tufted undershrub with short wiry stems. Flowers pink. —Nagrota and Bhuintar.

129. **Myrsine africana** Linn. (Myrsinaceae)

A small pubescent shrub. Fruits in small axillary clusters. —Jari.

130. **Oenanthe stolonifera** Wall. (Umbelliferae).

An almost glabrous herb. Flowers white in an umbel. —Nagrota.

131. ***Oenothera rosea** Sol. (Onagraceae),

An erect herb with pink flowers. —Nagrota.

132. **Olea cuspidata** Wall. (Oleaceae).

A tree with scaly branches. Flowers white, in short axillary panicles. —On way to Jari.

133. **Opuntia dillenii** Haw. (Cactaceae).

A low spreading bush with phylloclades. Flowers yellow or orange tinged. —Nagrota and other places.

134. **Orchis latifolia** Linn. (Orchidaceae).

A glabrous herb. Flowers dull purple, the lip darker spotted. —On moist ground,—Pulga.

135. ***Oxalis repens** Thunb. (Oxalidaceae).

A pubescent diffuse herb. Flowers yellow, sub-umbellate. —Bhuintar.

136. **Parochetus communis** Buch - Ham. (Papilionatae).

A hairy herb, with deep violet-blue flowers. —Pulga.

137. ***Passiflora coerulea** Linn. (Passifloraceae).

A large twiner with clock like flowers. Cultivated. —Bhuintar.

138. ***Pavetta indica** Linn. (Rubiaceae)

A large shrub. Flowers white, fragrant, in flat topped corymbs. —Nagrota.

139. **Pennisetum orientale** Rich. (Gramineae).

Culms 2-6 ft. bearing dense spike-like racemes. Bristles not branched. —Bhuintar.

140. ***Phaeneilema scapiflorum** (Wt.) Bruch. - *Aneilema scapiflorum* Wt. (Commelinaceae).

A herb with tuberous roots. Flowers small in panicles. —Nagrota.

141. **Philadelphus coronarius** Linn. (Saxifragaceae).

An erect shrub. Flowers white, orange-scented, in terminal racemes. —On way to Pulga.

142. **Phlomis bracteosa** Royle (Labiatae).

An erect hairy herb. Flowers dull blue-purple, crowded in large axillary whorls. —Pulga.

143. ***Phytolacca acinosa** Roxb. (Phytolaccaceae)

A glabrous succulent herb. Flowers small, pale-green. —Jari, Kasol.

144. **Picrasma quassioides** Benn. (Simarubaceae).

A tall shrub. Flowers small green in axillary panicles. —On way to Pulga.

145. **Pilea scripta** Wedd. (Urticaceae).

A glabrous herb upto 4 ft. high. Leaves lanceolate, teeth small. Achenes rough. —Kasol.

146. **Plantago lanceolata** Linn. (Plantaginaceae).

A herb with long lanceolate leaves. Spikes ovoid or shortly cylindric, 1-1.5 in. long —Jari.

147. **P. major** Linn. (Plantaginaceae).

A stemless herb with radical leaves. Spikes cylindrical upto 15 in. long. —Nagrota.

148. **Plectranthus rugosus** Wall. (Labiatae)

A small shrub with white flowers. —On way to Jari.

149. **Plumbago zeylanica** Linn. (Plumbaginaceae).

A diffuse rambling undershrub. Flowers white in terminal glandular spikes. —Nagorta.

150. **Poa annua** Linn. (Gramineae)

Culms slender 6-12 in. Panicale stiff; spikelets numerous, shining. —Bhuintar and Jari.

151. **Podophyllum hexandrum** Royle = *P. emodi* Wall. (Berberidaceae).

A glabrous, succulent, erect herb. Flowers solitary, rarely two, cup-shaped, white or pink. (Important drug plant) —Pulga 11,000-13,000 ft.

152. **Pogonatherum paniceum** Hack. = *P. saccharoideum* Beauv. (Gramineae).

Spikelets awned, imbricate, on the fragile, hairy, solitary terminal, slender spike. —Nagrota.

153. **Polygala abyssinica** R. Br. (Polygalalaceae).

A perennial, glabrous or pubescent herb with purple flowers. —On way to Jari.

154. **Polygonatum verticillatum** Allioni. (Liliaceae).

Rootstock creeping. Flowers small white, tinged with green. —Jari.

155. **Polygonum capitatum** Buch-Ham. (Polygonaceae).

Rootstock woody; stems many. Flowers pink in dense heads. —Nagrota.

156. **P. plebejum** R. Br. (Polygonaceae).

A prostrate herb. Flowers white or pale in axillary clusters. —Bhuintar.

157. ***P. posumbu** Ham. (Polygonaceae).
A slender flaccid herb. Flowers small, in erect filiform 1-3 in. long racemes.—Nagrota.

158. **Populus ciliata** Wall. (Salicaceae).
A lofty tree. Male catkins 2-4 in. long, interrupted, female catkins 6-9, in. long, lax in fruit. —Pulga and other places.

159. **Potentilla argyrophylla** Wall. (Rosaceae).
A pale tomentose herb. Flowers in terminal panicles. —Pulga.

160. **P. atrosanguinea** Lodd. (Rosaceae).
A pale tomentose herb. Flowers crimson red. —Pulga.

161. **Primula denticulata** Sm. (Primulaceae).
A slightly mealy herb. Flowers dark purple to pale-lilac. —Pulga.

162. ***P. duthieana** Balf. f. and Sm. (Primulaceae).
A herb with linear or oblanceolate leaves and strongly scented yellow flowers. —Pulga.

163. ***P. macrophylla** Don. (Primulaceae).
A herb with pale or deep purple flowers. —Pulga.

164. ***P. rosea** Royle (Primulaceae).
A small glabrous herb with rose-red flowers. —Pulga.

165. **Prinsepia utilise** Royle (Rosaceae).
A glabrous spiny shrub. Flowers white, in short axillary racemes. Fruits drupaceous, oblong purple. —Kasol and Pulga.

166. **Punica granatum** Linn. (Punicaceae).
A shrub with large red flowers. (Wild Pomegranate.) —Jari.

167. **Pyrus pashia** Buch-Ham. (Rosaceae).
A small tree. Flowers white tinged with pink. —Nagrota

168. **Ranunculus laetus** Wall. (Ranunculaceae).
A herb with long appressed hairs all over. Flowers I in. diam. bright yellow. —Bhuintar.

169. **R. sceleratus** Linn. (Ranunculaceae).
A pale green glabrous herb. Flowers yellow ¼ in. diam. —Bhuintar.

170. **Rhamnus virgatus** Roxb. (Rhamnaceae)
A spinous shrub or small tree with flowers crowded in the axils of the clustered leaves. —Pulga.

171. **Rhododendron arboreum** Sm. (Ericaceae).
A tree with red or pink flowers crowded in large head-like corymbs. —Kasol.

172. **R. campanulatum** Don. (Ericaceae).
A Shrub up to 12 ft. high. Flowers campanulate, pale-pink.—Pulga, 11,000-12,000 ft.

173. **R. hypenanthum** Balf.-*R. nthopogon* Don (Ericaceae).
A shrub 1 ft. high, highly aromatic. Flowers sulphur-yellow.—On way to Rorich Sar.

174. **R. lepidotum** Wall. (Ericaceae).
An aromatic shurb, 1-4 ft. high. Flowers dingy yellow or pale pink-purple.—Pulga.

175. **Rhus succedanea** Linn. (Anacardiaceae).
A tree with yellowish green flowers. Leaves glabrous. —Kasol.

176. **R. wallichii** Hook. f. (Anacardiaceae).
A tree with yellowish green flowers. Leaves tomentose. —Kasol.

177. **Rosa macrophylla** Lindl. (Rosaceae).
An erect prickly shrub. Flowers pink, solitary or corymbose. —Pulga.

178. **R. moschata** Mill. (Rosaceae).
A prickly climber. Flowers white, in terminal cymes. —Jari and on way to Pulga.

179. ***R. multiflora** Thunb. (Rosaceae).
A climbing rose with double pink flowers in corymbose clusters. —Nagrota.

180. ***Rotala rotundifolia** Koehne. (Lythraceae).
A small herb with pink flowers in dense terminal spikes. —Nagrota.

181. **Roylea calycina** Briquet.—*R. elegans* Wall. (Labiatae).

A woody undershrub with grey bark. Corolla white tinged with pink.
—Nagrota and Bhuintar.

182. **Rubus lasiocarpus** Sm. (Rosaceae).

A large spreading shrub. Flowers dark pink in tomentose panicles. —On way to Kasol.

183. **R. niveus** Wall. (Rosaceae).

A large rambling shrub. Flowers pink, solitary or in small clusters. —Pulga.

184. ***Rumex acetosa** Linn. (Polygonaceae).

A herb with flowers in axillary clusters.
—Pulga.

185. ***R. dentatus** Linn. (Polygonaceae).

An erect herb. Flowers small, green.
—On way to Jari.

186. **Salix daphnoides** Villars. (Salicaceae).

A large shrub or small tree. Male catkins 1-2 in. erect; female catkins nodding or pendulous, both densely hairy. —Pulga.

187. **Salvia moorcroftiana** Wall. (Labiatae)

A tall herb, usually woolly or cottony. Flowers pale-blue, lilac or almost white.
—Bhuintar, and on way to Jari.

188. **S. plebeia** R. Br. (Labiatae).

A roughly pubescent herb. Flowers white in glandular inflorescence —Bhuintar and Jari.

189. **Sarcococca pruniformis** Lindl. (Euphorbiaceae).

A glabrous shrub up to 4 ft. high. Flowers pale yellow, in short axillary racemes.
—Jari and Kasol.

190. **Saussurea candicans** C.B.Cl. (Compositae).

A herb with cottony stems. Heads solitary or corymbose; flowers pale-red. —Kasol.

191. **Scrophularia himalensis** Royle (Scrophulariaceae).

An erect herb. Flowers small dingy green-purple. —On way to Pulga

192. **Sedum adenotrichum** Wall. (Crassulaceae).

A glandular pubescent herb. Flowers white streaked with pink. —Jari.

193. **S. rosulatum** Edgew. (Crassulaceae).

A succulent herb. Flowers white, long stalked in open, loose cymes —Jari.

194. ***S. tibeticum** Hook. f. and Th. (Crassulaceae).

A small succulant herb. Flowers rose or purple colored. —Pulga.

195. ***Senebiera pinnatifida** DC. (Cruciferae).

A slightly hispid herb. Flowers minute, in short leaf-opposed racemes. —Nagrota.

196. **Senecio nudicaulis** Buch-Ham. (Compositae).

A glabrous herb with grooved stem. Flowers yellow. —Nagrota.

197. **Sibbaldia parviflora** Willd.-*Potentilla sibbaldi* Haller (Rosaceae).

A samll hairy herb. Flowers yellow, minute.
—Above Pulga.

198. ***S. purpurea** Royle (Rosaceae).

A procumbent branching herb; rhizome or stem flexuous, rooting, 4 in. long, clothed with stipular sheaths. Flowers pale purple.
—Pulga, *13,000 ft.*

199. **Silene inflata** Sm. (Caryophyllaceae).

A herb, ascending, rarely erect. Flowers few; calyx inflated. —Pulga.

200. ***Silybum marianum** Gaertn. (Compositae).

An erect glabrous herb. Flowers rose-purple, in heads. —Jari.

201. **Smilacina pallida** Royle. (Liliaceae).

A herb. Flowers less than $\frac{1}{4}$ in. long, white, in terminal simple or branched racemes.
—Pulga.

202. **Smilax aspera** Linn. (Liliaceae).

A climber; branches grooved. Flowers small white. Fruits blue-black when ripe
—Nagrota

203. **S. parvifolia** Wall. (Liliaceae).

A climbing shrub; branches smooth. Flowers purple, in solitary umbels, bracteate Tendrils present. —Jari

204. ***Solanum pseudo-capsicum** Linn. (Solanaceae).

A low erect undershrub with pale yello flowers. —Bhuinta

205. **S. verbascifolium** Linn. (Solanaceae).
An erect shrub. Flowers white, in compound cymes. —Nagrota.

206 **Spiraea bella** Sim. (Rosaceae).
A glabrous shrub. Flowers pink, in terminal compound corymbs. —Pulga.

207. **S. canescens** Don. (Rosaceae).
A softly tomentose shrub. Flowers white, in small compound corymbs.
—At all the places.

208. **S. lindleyana** Wall.-*S. sorbifolia* Linn. (Rosaceae).
A tall glabrous shrub. Flowers in terminal panicles white. —Jari.

209. **S. vaccinifolia** Don. (Rosaceae).
A tomentose shrub. Flowers in terminal tomentose corymbs white. —Kasol.

210. **Staphylea emodei** Wall. (Sapindaceae).
A shrub or small tree with panicled white flowers. —Pulga.

211. **Stellaria aquatica** Scop. (Caryophyllaceae).
A pubescent viscid herb. Flowers white, in leafy, axillary or terminal cymes. —Pulga.

212. **S. media** Linn. (Caryophyllaceae)
A glabrous or pubescent herb. Flowers white, in axillary or terminal cymes.
—Pulga.

213. **Symplocos crataegoides** Buch-Ham. (Styracaceae)
A shrub or small tree. Flowers white, small, in terminal panicles. —Pulga.

214. ***S. spicata** Roxb. (Styracaceae)
A small tree. Flowers closely sessile. Fruit globose. —Nagrota.

215. **Taraxacum officinale** Wigg. (Compositae).
A herb with milky juice. Flower-heads yellow, solitary. —Kasol and Bhuintar.

216. **Teucrium royleanum** Wall. (Labiatae).
A tomentose herb. Flowers about ½ in. long, white or yellow-white.
—Bhuintar and Jari.

217. **Thymus serpyllum** Linn. (Labiatae).
An aromatic, hairy, almost procumbent, often tufted shrub. Flowers small, purple.
—Pulga.

218. **Trachelospermum fragrans** Hook. f. (Apocynaceae)
A glabrous climber. Flowers white, fragrant, in terminal or axillary cymes.
—Kasol.

219. **Trigonella emodi** Benth. (Papilionatae).
A glabrous or pubescent herb with pale yellow flowers. —Pulga.

220. **Trillium govanianum** Wall. (Liliaceae).
A glabrous herb. Leaves three, shortly stalked. Flowers solitary, lurid-purple.
—Pulga.

221. ***Trollius acaulis** Lindl. (Ranunculaceae).
Erect herb, 3-6 in high. Stem leafy above middle. Leaves palmate. Flowers solitary, terminal, 2 in. in diam. Petals 12-16, short clawed. —On way to Rorich-Sar.

222. **Urtica dioica** Linn. (Urticaceae).
An erect herb clothed with stinging hairs. Flowers unisexual, small green. —Pulga.

223. **Valeriana wallichii** DC. (Valerianaceae).
A pubescent herb. Flowers white or tinged with pink, in a corymb. —Pulga.

224. **Verbascum thapsus** Linn. (Scrophulariaceae).
An erect herb, densely clothed with soft, yellow-grey, stellate hairs. Flowers yellow in terminal spikes. —Nagrota.

225. **Veronica agrestis** Linn. (Scrophulariaceae).
A pubescent herb. Flowers blue or white, small. —Jari.

226. ***Viburnum nervosum** Don. (Caprifoliaceae).
A shrub. Flowers small, light rosy.
—Nagrota.

227. **V. stellulatum** Wall. (Caprifoliaceae)
A shrub with dark bark. Flowers small, white, pubescent. —Kasol.

228. **Vicatia coniifolia** DC. (Umbelliferae).
A glabrous herb with finely divided leaves. Flowers minute, dark red. —Pulga.

229. **Viola biflora** Linn. (Violaceae).
A small glabrous or pubescent herb, erect, up to 10 in. high. Flowers 1 or 2 on the same stalk, pale yellow; lower petals streaked with black. —Pulga.

230. **V. serpens** Wall.—(Violaceae)
A glabrous herb with scattered hairs. Stem short, distinct. Flowers lilac. —Nagrota and Jari.

231. **Viscum album** Linn. (Loranthaceae).
A glabrous parasitic shrub with repeatedly forked, branches. Flowers clustered in the forks of the branches. —Jari and Pulga.

232. **Vitex negundo** Linn. (Verbenaceae)
A shrub or small tree. Flowers ⅓ in. blue-purple, in short cymes, forming a terminal panicle. —Nagrota.

233. **Vitis jacquemonti** Parker (Vitaceae).
A robust climber. Leaves rusty-brown tomentose below. Flowers white. —Kasol.

234. ***V. semicordata** Wall. (Vitaceae).
Glabrous, climbing over trees. Flowers yellow green, in spreading cymes.—Kasol.

235. **Wikstroemia canescens** Meissen. (Thymeleaceae).
A silky pubescent shrub 1-3 ft. high. Flowers yellow or white, in heads or spikes. —Pulga.

236. ***Withania somnifera** Dunal. (Solanaceae).
An erect undershrub. Flowers with tomentose corolla. —Bhuintar.

237. **Xolisma ovalifolia** (Wall.) Rehd.- *Pieris ovalifolia* Don. (Ericaceae). A small glabrous tree. Flowers white. —Kasol

238. ***Zephyranthes carinata** Herb. (Amaryllidaceae)
A bulbous herb. Flowers 2.5 in., spathe 1.5 in. —Pulga

239 ***Zizyphus rotundifolia** Lamk. (Rhamnaceae)
A shrub with the flowers in cymes.—Nagrota.

II **Ferns and Fern Allies** :—

240. ***Diplazium polypodioides** Mett. —Kasol

241. ***Equisetum arvense** Linn. —Bhuintar and Kasol.

242. ***Lygodium japonicum** Sw. —Nagrota.

243. ***Onychium multisectum** F. Henderson. —Jari.

244. ***Pteridium aquilinumc** Linn). Kuhn. —Kasol.

245. ***Pteris cretica** Linn. —Kasol.

TILLAMOOK BURN: NATION'S GREATEST TREE-PLANTING JOB

(NEW YORK HERALD TRIBUNE)

ORGEON ALLOTS $10,500,000 TO RECLAIM AREA

BY ELLIS LUCIA

FOREST GROVE, Ore.

Oregonians are digging into their pockets to spend $10,500,000 to plant more trees. The state last fall raised the curtain on the greatest forest rehabilitation program ever attempted on the North American Continent. The nation's leading lumber-producing state is being turned into a gigantic forest laboratory.

In a state where trees grow with the abundance of corn in Iowa, such a project may seem at first glance to be about as useless as buying a fur coat for a movie star. Yet under the surface is a different picture. Timber stocks in Oregon have been depleted at a high rate of speed in the last few years. Millions of board feet were logged from the state's rich timber lands to help in World War II. The post-war demand for lumber has kept mills humming at full speed.

However, a series of disastrous fires has been even a greater cause for alarm. Huge sections of forest areas have been laid waste. Next to nothing was being done to reclaim these lands. The problem was brought home to residents of the northwestern part of the state after the war when major mills cut their last logs. The timber simply wasn't in the hills. The mass of loggers and millmen have moved to southern Oregon, Eugene and Roseburg are now the lumber capitals, for they lie within short distances of the last great timber stands within the continental United States.

What Oregonians saw was the ominous threat to 29,000,000 acres of timber lands and their foremost industry, basis for the state's economy. In 1948 alone, Oregon forests produced 7,000,000,000 board feet of lumber. It accounted for 654,000,000 feet of plywood and furnished wood for 545,000 tons of pulp. The forests bring Oregon an annual income of $600,000,000. Its employment roster includes 60 per cent of the state's workers.

As a result of action by the voters, the state last summer got into the tree-farming business on a large scale. The $10,500,000 forest rehabilitation program will attempt to reclaim 750,000 state-owned acres of poorly stocked or blackened timber lands.

Focal point for this huge undertaking is the 300,000-acre Tillamook Burn, once one of the richest timber-producing regions in the world. Situated in the northwest corner of the state, it has been thrice ravaged by fire since 1933. The big burn is a constant reminder of the state's dwindling timber reserve. Its proximity to Portland, Oregon's only metropolitan centre, makes its bleached snags a distasteful section through which motorists on their way to the Oregon beaches must drive.

In the 1933 fire alone, 12,500,000,000 board feet of top-grade timber were consumed, worth $10,000,000 at today's prices and representing a pay-roll loss of $200,000,000. Ashes rained down on ships 500 miles at sea and to a depth of two feet on the beaches thirty miles away. Fire reached to a height of 40,000 feet. It left Oregon $100,000,000 poorer.

Then in 1939 the burn exploded a second time, ravaging 225,000 acres of green old-growth timber. In 1945 a third fire crackled through 110,000 acres, threatening the watersheds of several towns, costing the lives of

three men, destroying 10,000 acres of young trees and the last seed sources.

Private companies have done an amazing job of salvage. Several million board feet are still being recovered daily. High lumber prices of the last few years have made this slavage job economically profitable.

Yet today the Tillamook Burn, still drenched by heavy coastal fogs which make trees grow, is a wasteland of stumps, snags and brush. It is a powder keg in summer, an idle area too steep and rocky for anything but growing trees. The problem area is 500,000 acres.

This is the area, foresters hope to replant. They know if they can lick the problems facing them in the big burn, they can lick them anywhere. Groundwork was laid by the 1947 Legislature which passed a forest research bill. A tax of five cents a thousand board feet was levied on logs. Sixty per cent went to the state forest products laboratory at Corvallis to further new methods of utilizing waste wood products. Forty per cent financed experiments in forest protection, management and rehabilitation. Many planting experiments were carried out in the Tillmook Burn, testing different types of trees under varied conditions. Tests also were concerned with combating tree diseases and rodent control.

Under the new reforestation act, work must be done entirely on state owned lands. The first step was to survey the burn to determine state boundaries. Other mapping crews are determining the procedure of tree planting to be carried out in different sections. Such surveys will decide whether seeding will be by airplane or whether hand planting will be necessary.

Forestry is a new science. Experimental work in the last two years has taught foresters a great deal about disease control, snag-falling, fire protection and serial seeding. The experiments are continuing. Use of such data will insure against wasteful expenditure of public funds.

Much of the seeding will be done by helicopter wherever possible. One ton of Douglas fir seed will be required to restock 6,000 acres by direct seeding. Hand-planting will cost $20 an acre. It takes a man a full day to plant 680 trees. Aerial seeding will cost from $6 to $8 an acre. The state purchases cone seed for the project from cone gatherers.

APPLYING OF GROWTH SUBSTANCES TO THE VEGETATIVE PROPAGATION OF WOODY PLANTS

By Cuttings

Biological Abstracts, Vol 23, No. 2. Feb. 1949.

5138.—KOMISSAROV, D.A. Results of experiments with application of growth substances to cuttings from numerous species of trees and shrubs are reported. Heteroauxin was the most effective of the substances used. A mixture of 0.01 per cent heteroauxin and 0.01 per cent phenylacetic acid solutions in equal volumes was as effective as 0.01 per cent heteroauxin solution alone, for *Thuja occidentalis* and *Ribes aureum*, and was much more effective than 0.01 per cent phenylacetic acid solution alone. A mixture of 1 part each of a-naphthaleneacetic acid, heteroauxin, and anthracene per 1,000, parts talc caused nearly 100 per cent rooting of *Quercus suber*. Nicotine sulfate and anabasine sulfate in 0.02 per cent concentration with 6 hours treatment resulted in rooting of 70 per cent and 60 per cent of *Q. suber*, compared with 20 per cent for untreated cuttings. The stimulating effect of heteroauxin and a-naphthaleneacetic acid at high concentration (0.02 per cent) upon rooting of poorly lignified cuttings of *Larix sibirica* and *Quercus pedunculata* increased with decrease in acidity of water solutions. The most effective method of treatment tested was immersion of basal ends of cuttings in weak water solutions (concn. 0.005—0.02 per cent) for 16-36 hours. The effect was similar with a mixture of growth substances and talc (1-3 ppm.) The stimulating effect varied with species. Effectiveness of treatment depends on the physiological state of the cuttings and environmental conditions in the seedbed. Growth substances had little effect on budding time of summer cuttings or on subsequent growth. Anatomic examination of *Salix caprea* cuttings treated with heteroauxin showed that this

substance caused intensive development of bast and bark parenchyma, and the initiation and development of root "germs". Natural growth substances play a great part in root formation. Plants difficult to propagate by cuttings, such as *Q. suber* and *Q. caprea*, contain no special substances in the bark or leaves that may suppress the rooting capacity of *Salix viminalis* and *Euonymus japonica* cuttings. Absence of stimulating effect of synthetic growth substances upon root formation may be caused by making the cuttings at the wrong time, by unfavourable conditions for rooting, by an insufficient supply of the substances at the points of root origin, by anatomic structure, or by inadequate cell response.—W.N. Sparhauk.

Experiments on the rooting of tung tree cuttings.

(*Biological Abstracts, Vol. 23., No. 2, Feb. 1949*)

5156.—YIN, H.C., and C.H. LIE. (Tsing Hua U., Kunming, China.) Investigations carried out at Kunming, China, were made on root formation in tung tree cuttings in relation to growth substances, time of year at which cuttings were taken and region of shoot from which cuttings were taken. Indoleacetic acid and napthaleneacetic acid in concentrations ranging from 100 to 400 ppm. were used. The growth substances (1) enhanced root formation as compared with untreated cuttings during December, January and February when untreated cuttings rooted readily (2) induced root formation during November, March, April, May and June when untreated cuttings would not root, (3) did not induce roots during July, August, and September. The optimum concentration for indoleacetic acid was 400 ppm. and for napthaleneacetic acid was 100 ppm. Higher rooting response was shown by cuttings taken from the basal part of the shoot than from regions higher up.

W.C. COOPER.

THE WHYS AND WHEREFORES OF A MODERN FOREST ROAD

By W. Kay Conrad

General Forestry Agent, Lincoln Green Demonstration Forest,
Southern Railway System, Dorchester, S.C.

(Southern Lumberman)

The stage was set and the actors were ready and willing? After several months of drought, farmers seemed to be picking the windiest day to do their field burning. Fanned by a strong north wind, a hot fire was racing through tinder-dry grass fields and pine tops toward the north boundary of the Southern Railway System's 14,000 acre Lincoln Green Demonstration Forest.

Alerted by a report from the nearby state fire tower, our own crew fought this fire along our boundary for a long, hot half-mile. As an extra precaution, an emergency contractor's crew was sent for and arrived just in time to carry on the fight for the exhausted forest crew. Had this crew been delayed for fifteen or twenty minutes the fire might well have crowned and killed several hundred acres of valuable pole timber.

The important point in this instance, however, is that the arrival of the emergency crew was the first "pay-off" on our newly completed forest road. Travel time had been cut by some thirty minutes—a vital time margin on a high fire hazard day.

As those familiar with the coastal plain flatwoods can testify, fire danger can be very high on the three or four foot elevations called hills, while at the same time suppression crews can bog down on flooded roads while crossing the "bays" or low places.

This demonstration forest of the Southern Railway has been managed for 25 years on a business like basis, and has shown an annual net return. The county maintained roads adjoining and crossing the forest that, coupled with some hand-maintained interior truck

trails, furnished fair access for protection from fire until recent years. It seemed to be good management to let contractors get their products out as best they could. However, in recent years improved markets have made lighter cuts possible with a return to the same area every four to five years desirable from a management standpoint. This factor, coupled with increasingly heavier loads, had broken down our "Model T" forest roads—limiting our harvesting operations to only the best and most accessible stands of timber. We found that operators could not be interested in light selective cutting unless a modern access truck road was located within a half-mile or three-fourth of a mile from the timber offered for sale.

In the interest of achieving better protection from wildfire and to enable orderly harvesting of light, selective pole, puplwood, and sawtimber cuts, it was decided in the fall of 1949 to contract for construction of some three miles of graded forest road. Construction by a contractor was considered necessary since we had neither the equipment nor the "know-how," and the size of this forest did not seem to warrant purchase of equipment and employment of special personnel. It should be noted that it is not my purpose to recommend here specific engineering procedures for forest roads, but rather to arouse interest in their value in the long range management of timberlands, especially the smaller acreages. Undoubtedly, many will be better equipped from an engineering standpoint to plan and build roads—possibly at lower cost figures than we quote.

In order to develop a contract to submit for bidding, forest forces made a transit survey of the road location with side and center line stakes at 100′ intervals for a total of 2.7 miles. Fill stakes were marked with the number of inches of required fill through all bays and low places. A map showing this data was developed and a sketch giving the following cross section data to scale was also developed:

1. Width of settled roadway or bearing surface to be 10′ (or 5′ each side of centre line).
2. Maximum slope of ditch to be 1′ to 4′.
3. Minimum elevation of 10′ settled roadway above surrounding ground to be 1′
4. Edge of ditch on one side of roadway to edge of ditch on other side of roadway to average not less than 27′.
5. Total width of right of way to be cleared of stumps, limbs, and debris 30′ (this 30′ to be reduced to practical widths in passing through bays or other low places).

Three competitive bids were secured, and a low of $3,200,00 was accepted. This was at the rate of approximately $1, 185.00 per mile, and included a total of some 1700′ through places requiring filling ranging from 6″ to 3′. Sixteen inch diameter, reinforced concrete drain pipe sections were placed by forest forces where necessary.

Since the new road required considerable clearing operations by the contractor through heavy pole and pulpwood stands, a profitable salvage operation was possible. In accordance with a request from the contractor for 36″ high stumps, our Rangers marked each tree to be cut within the right of way with a line of tree marking paint 36″ above the ground. All poles and pulpwood were cut at this line and the resulting high stump was used for leverage in the bulldozer clearing operations. Over $8,00,00 was realized from salvage of poles and pulpwood from the right-of-way clearing operation.

The contractor cleared practically all of the stumps within the right of way, pushing them beyond the 30′ required clearance area, with a D-4 powered dozer. A grading machine completed the cutting of the ditch and further grading work. Filling operations included the use of some four or five dump trucks and a Caterpillar tractor-operated overhead loader.

Since we have a 38 H.P. Cletrac tractor of firebreak plowing, we purchased a used 5,800 lb., Galion road grader for $350,00 for the maintenance of the road. This type grader can be purchased at a very reasonable figure since most county maintained roads are now worked with a one-man operated self-propelled grader.

Although we have a very satisfactory road built at a reasonable cost, it is believed that any further road building on the forest will be done by contracting stump removal at a $15·00 to $20·00 per acre cost, using our own labour. While this may not produce quite as high grade road, it should reduce the cost to around $800,00 per mile. Also, as a result of our experience, the following was learned:

1. It is unreasonable to expect an average fill of 1′ for the 10′ required roadway since removal of stumps greatly reduces the volume of soil available in the 27′

roadway. Experience has shown that the 2″ to 3″ average fill above surrounding soil level provides a good stable roadbed without excessively steep roadway slopes.

2. In the coastal flatwoods area, fills on the sides of a hill are of equal importance with fills through the lowest parts. Springlike conditions will often be found on the sides of a hill and this should be noted in laying out road locations, including fill specifications where such seem to be necessary.

We have found the modern forest roads are relatively inexpensive to build, and repay us through better protection and the continuous movement of forest products, regardless of ground conditions.

THE MEANING AND IMPORTANCE OF PROVENANCE *

By J. C. VARMA

ASSISTANT CONSERVATOR OF FORESTS, ANDAMANS

The term 'provenance' is derived from the Latin 'pro-venio', meaning 'place of origin'. It signifies the geographic region where a type is found, with its climatic and physiographic factors. Even as the study and development of forestry started from the European Continent, the first work on provenance was also initiated there. Over a century ago Vilmorin raised plantations of *Pinus sylvestus* from seed from Germany, France, Scotland and Russia, all side by side. But it was not till the end of the last century that careful studies were started by people like Dengler, Halden, Rubner, Münch, Oppermann and Schotte, (the last in Sweden) on the question of seed provenance, in an attempt to obtain varieties capable of high yield, adaptability to various soil conditions, and the ability to resist frost and fungus attack.

Perhaps the problem was not of such great importance in the past when natural regeneration was the only method employed and man did not interfere with the natural distribution of any type. With the practice of artificial regeneration and planting, on account of economic reasons, the problem has become more complicated and the interpretation of facts more difficult. The difficulty is further enhanced with the bringing-in of foreign species, even when these prove to be of great value, for there are considerable risks of loss when seed or plants of unsuitable stock are employed. It is thus of prime importance to carry out provenance studies of all species, whether exotic or indigenous.

The first need in provenance studies is the realisation of the full extent of natural variability of a type over its entire range of distribution. It has been increasingly realised that those types which were hitherto considered as pure are in reality a complex of genotypes with very variable characters. The differences may, however, be so slight and so difficult to detect, that it may not be possible to identify them on purely morphological characters, but yet significant enough for one to define them as climatic or local races. Turesson was of the opinion that species were made up of ecotypes or natural biotype groups, only those types which were adapted to the climatic and edaphic factors of a site being perpetuated. In other words, "Provenance is a matter of genecology or race-ecology, a species extending its range by the selection of suitable biotypes". Instances were cited where a species had different genotypic make-up in different parts of its range due to loss of heritable units in migration. This ecological theory of the origin of races, with more emphasis on heredity is also supported by Büsgen and Münch. It may be stated, however, that neither of these two factors can be studied in isolation from the other, the type being the resultant of the interaction of the genotype and the environment.

It would not be out of place to discuss Huxley's cline concept in brief, as it has a practical bearing. In certain cases of intraspecific variation, the individuals comprising a species may be arranged in an orderly sequence depending on the gradation of certain characters or groups of characters. A cline may thus be defined as "a pattern of genetical variation in which the differences of a character or characters are graded in a definite direction in space." As applied to the provenance of forest trees, the type of cline which would be most useful and helpful would be that in which the character gradient is related to geographical distribution. For this the term geocline was proposed by Huxley, though topocline as suggested by Gregor, is generally accepted as more suitable. An interesting example of this is mentioned by Lindquist for Wych Elm with a North to South gradient in leaf form in Europe, the leaf form being narrow in the Northern part of Europe and broad in the Southern. Useful conclusions can be drawn by a silviculturist from such data. Thus it may be possible to associate leaf form with greater resistance to fungal attack, etc.

Having realised the fact that most, if not all, species consist of races or strains which have developed under specific environments, the problem of provenance may be briefly stated as one that involves the discovery of climatic or physiographic races that will grow best in any particular region or locality. Generally, these racial characters are heritable. It therefore follows that where two regions have a more or less similar climate, a strain imported from one to the other will develop in the new environment in a way similar to that which obtained in

* Received for Publication on 13-9-1949.

the region of origin. But where adverse climatic changes occur, the imported strain may become decadent early in life, develop poor form, show marked susceptibility to climatic extremes, or may fail to survive completely. It is the purpose of provenance studies in such cases to determine what are the chances of success of an exotic race, before large scale imports are made.

Provenance studies rest upon the establishment of test plantations of seeds from various sources in extensively replicated plots, with a thorough knowledge of the ecological factors operating both in the place of origin and the planting locality. An ecological approach is essential in order to strip off the mask of environment from over any local type.

In laying out test plantations, it is of utmost importance to study the aspect, topography etc., of the plantation area, as minute differences may have far-reaching effects. For instance, if the area is sheltered, there is a possibility of retaining at the very outset, many of the strains susceptible to exposure. If the purpose is to find out frost hardy or drought resistant strains, there is more reason to work the other way, in exposing the strains to extremes. This would obviate any possibility of erroneous results in borderline cases, as for example Scots Pine. This species is generally considered to be frost hardy and there is a tendency in England to use it in areas subjected to severe frosts. But critical examination shows that it does suffer from frost damage, though in a less obvious manner and there are grave chances of its failure in severe frost areas. The type and extent of work needed may well be illustrated by the elaborate work of Nageli and Bürger in Switzerland on *Pinus* sp., *Quercus* sp., *Picea*, *Abies*, *Larix*, *Fagus*, *Acer* etc. It was started in 1898 in order to study site races, form races, the influence of geographical location, latitude, altitude, soil, precipitation, form, age and position of parent tree in the stand. Their results indicate that colour and size of needles and leaves, crown form, stem form, growth periods and resistance to frost, heat, light, snow, fungi and insects are heritable characters. They claim that these investigations are of great importance since they are to be applied to protection forests in many regions where natural regeneration is practised.

The nature and extent of these experiments and the time and expense involved, emphasize the need for co-operative investigations not only in different regions in a country, but also on an international basis. Further, to avoid rapid deterioration of forest trees already taking place from use of seed from inferior stands and 'cull' trees left in logging etc., and in order that the results from provenance studies may be of any use, it is imperative to control seed origin in forestry. This would necessitate the issue of origin certificates in the case of recognisedly good stands by a Government or semi-official agency; the elimination of stands and individuals of inferior quality; restrictions on the use of seed of unknown origin; and restriction and regulation of imports of any foreign variety which has not been subjected to provenance tests in the importing country. Important steps have already been taken in regard to this problem in many Western countries, some of which have passed legislation to exclude foreign seed and cones from inferior native stands. Thus, in Sweden, all seed used in the Government forests is collected under a rigid control; seed privately used is distributed from seed plants operated by the Forest Conservation Boards; and imported seed is dyed with eosin in the Customs so that they can be recognised easily. In Germany, after the first world war, a control board was established which issued licenses to public and private nurseries and seed extraction plants, and designated stands recognised as suitable for cone collection. Guinier suggested the establishment of an international board for certifying the origin of forest tree seeds. This is already carried out in some countries for agricultural crops, by such agencies as the Seed Verification Service of the U.S. Dept. of Agriculture. There is little hope of insuring the use of proper seeds and their exchange from different countries as long as such establishments are not started everywhere.

To sum up, provenance studies aim at finding trees with the best genetical constitution, the determination of the effect of various environments upon them, and fitting in the former in their most suitable environments.

ON THE ECOLOGY AND SILVICULTURE OF *DENDROCALAMUS STRICTUS* IN THE BAMBOO FORESTS OF BHADRAVATI DIVISION, MYSORE STATE, AND COMPARATIVE NOTES ON THE SPECIES *BAMBUSA ARUNDINACEA*, *OXYTENANTHERA MONOSTIGMA* AND *OXYTENANTHERA STOCKSII*.

By K. KADAMBI, M.Sc., D. Sc. (MUNICH), DIP. FORESTRY, (HONS.),
MYSORE FOREST SERVICE

(Continued)

Bamboo Working Plans.

In October 1917, the preparation of a working plan for the exploitation of bamboos for the manufacture of paper pulp was undertaken for several forests of Shimoga and Kadur districts; among them were the forests:—Lakkavalli; Hebbagiri, Tegurgudda, Voddihatti, Muthodi, Aramballi, Chornedehalli, Kakanhosudi, Aldhara and Umblebyle. The work was carried out under the direction of Rao Sahib M. Rama Rao, special forest officer in Mysore, by M.V. Narasimhiya, Sub-assistant Conservator, assisted by M. Visweswariya, Forest Ranger. This plan was completed in February 1919. It was probably one of the earliest working plans in which the growing stock of bamboos was carefully enumerated and scientific exploitation specifically provided for under an independent working plan meant exclusively for the purpose.

The Working Plan Officer, M. V. Narasimhaiya, assisted by Ranger M. Visweswariya, reconnoitered nineteen State forests comprising about 329 sq. miles of forest land and rejected five State forests of an aggregate area of 62 sq. miles owing to the paucity of bamboo growth, gregarious flowering or heavy private rights therein. The remaining forests were carefully gone over and the bamboo covered areas in them marked on the forests maps, and the bamboo stocks enumerated in sample plots and valued for the whole area of each forest. Out of the 14 forests 3 namely, Kumsi, Purdhal and Umblebyle comprising 44 sq. miles were set apart for meeting the trade requirements and portions of Aramballi, Chornedehalli and Shankar covering about 8.8 sq. miles of bamboo area were reserved for the bamboo requirements of the neighbouring raiyat population. The net forest area which remained over for bamboo supply to the then proposed paper mill was 214 sq. miles distributed in 11 State forests. M.V. Narasimhaiya estimated from the above area an assured sustained annual supply of bamboo sufficient for manufacturing about 10,000 tons of paper during the first six years and about 12,000 tons of paper from and after the 7th year.

The silvicultural rules prescribed by M.V. Narasimhiya are said to have been based on a careful consideration of the local conditions in which the bamboos grow and on the recorded experience and knowledge of various forest officers in other parts of India. The estimate of the annual yield which was put at 25,000 tons for the first 6 years and 30,000 tons thereafter is said to be safe and conservative and one well within the limits of the annual increment.

This report, which is in many respects excellent for its days, was printed and issued to the concerned officers but it could not be actually brought into force as the paper industry was not started till about two decades later.

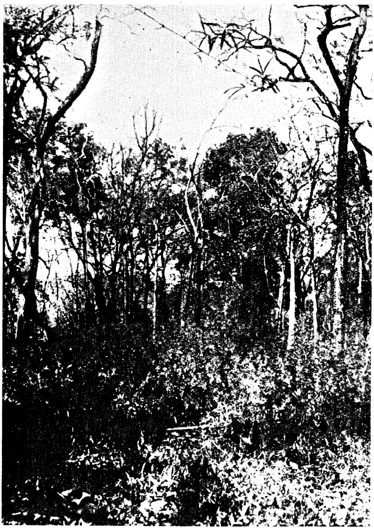
In 1936 and 1937 a revised and consolidated working plan was drawn up by the writer, in connection with firewood and timber supply, for the entire Bhadravati division but very little reference was made to bamboo exploitation therein. The following are some of the extracts from it pertaining to bamboo:—

> "The demand for bamboos has so far been small and practically limited to the annual sale of standing bamboos by the department and what is extracted by consumers on licenses. There is practically an unlimited stock of big* and small bamboo** in the forests covered by this plan, and a paper pulp plant is under construction at Bhadravati which will enable the industrial utilization of this valuable raw material ".

> "The felling of bamboos will be permitted without restriction up to the limits of the capacity of the forest".

*Big bamboo is *Bambusa arundinacea*.

**Small bamboo is *Dendrocalamus Strictus*.



A dense carpet of natural regeneration of *Dendrocalamus strictus* in Muthodi State Forest, Bhadravati Division, Mysore, following the gregarious flowering of this species between 1933 and 1935.

Photo : Author.
Feb., 1937.

A patch of *Oxytenanthera monostigma* on Sugalatti hill, Bhadravati Division, Mysore State. This bamboo is a strong light demander and is also drought resistant. It is generally found in patches in mixed-deciduous forest of qualities I and II, frequently on hill tops or upper slopes where the canopy is very open.

Photo : Author,

March, 1937.

In 1935 a report was drawn up by C. H. Eagles, under the title "*On the probable annual yield of bamboos in the Bhadravati and Shimoga divisions.*" The State forests within an average radius of five miles from main roads, waterways, tramways and railways were inspected and the areas under bamboos marked on the four inch scale maps.

The following forests were included in this report :—

Division.	**No.**	**Name.**
Bhadravati.	1.	Hebbagiri.
	2.	Tegurgudda.
	3.	Muthodi.
	4.	Kusgal.
	5.	Thadasa.
	6.	Nandigave.
	7.	Kakanhosudi.
	8.	Chornedehalli.
	9.	Aldhara.
	10.	Umblebyle.
	11.	Lakkavalli.
	12.	Aramballi.
	13.	Antaragange.
	14.	Tamadihalli.
	15.	Kukwada-Urbani.
Shimoga.	1.	Shakargudda.
	2.	Purdhal.
	3.	Anesara
	4.	Sakrebyle.
	5.	Kumsi.
	6.	Sudur.
	7.	Malandur.
	8.	Malali.
	9.	Chipli.
	10.	Kudi.
	11.	Arasalu.
	12.	Masrur.
	13.	Harohithlu.

A valuation survey was undertaken over a forest area of 445.66 sq. miles, of which 223.52 sq. miles contained bamboos of various kinds. An area of 81.36 sq. miles in Lakkavalli, Thadasa, Hebbagiri, Muthodi, Tegurgudda and Kuskal state forests were excluded owing to the gregarious seeding and death of *Dendrocalamus strictus.*

To arrive at the annual yield of bamboo in the areas mentioned above, enumeration of the growing stock in strip-lines was undertaken in each state forest. In addition to these lines, sample plots were laid out and separately enumerated to obtain greater precision of the estimate. The sample plots and strip lines varied in area from 2 to 90 acres according to the density of the growth in the different types of forests met with. In each strip-line and sample plot all bamboo clumps were counted up and in each clump all culms were counted under the following four different heads :—

(i) Green culms of one season.

(ii) Green culms of two seasons.

(iii) Green culms of three or more seasons.

(iv) Dead and dying culms.

The proportion of sample plots and sample strips to the total bamboo area worked out to 1.24 per cent in the case of *Bambusa arundinacea* and 0.37 per cent in the case of *Dendrocalamus strictus.*

These results were applied to the areas under bamboo in each forest, and the growing stock thus ascertained in order to arrive at the annual yield which is to represent the increment that could safely be extracted without materially affecting the growth of bamboo.

The annual possibility was estimated by C.H. Eagles at 22,537 tons of *Dendrocalamus strictus* from the forests of Bhadravati division and 25,860 tons from those of Shimoga. This report too, like its forerunner, was not brought into operation.

In August 1937, M.G. Venkatarao, then District Forest Officer, Bhadravati, prepared what he called "*A provisional scheme of work for the extraction and supply of bamboos to the Paper Factory at Bhadravati*". His scheme covered the forests Kakanhosudi, Chornedchali, Aldhara, Umblebyle, Aramballi, Antaragange, Kukwada-ubrani, Thamadihalli, Hebbagiri, Thadasa, Nandigave, Tegurgudda, Lakkavalli, Muthodi and Kuskal.

This scheme took into consideration only the first seven forests which can be tapped by the Mysore Iron and Steel Works tramlines and, after reserving the whole of Chornedehalli for the bamboo requirements of the local population, it estimated that about 16,920 tons of *Dendrocalamus strictus* and 1,780 tons of *Bambusa arundinacea* can be cut from the whole area of Kakanhosudi, one-half the area of Aldhara, Umblebyle and Aramballi, three-fourths, the area of Antaragange and one-third the area of Kukwada-ubrani. Reducing the above yield by 20 per cent. to allow for inaccessible areas or those too costly to exploit, M. G. Venkatarao

arrived at an annual yield of 15,000 tons of bamboo. In making the above calculations he assumed that 300 pieces of *Dendrocalamus strictus* and 100 pieces of *Bambusa arundinacea* , respectively, 18 feet long and air dry weigh one ton. M.V. Narasimhiya assumed 300 culms of air dry *Dendrocalamus* and 75 of similar *Bambusa* to weigh a ton while Eagles has assumed 250 culms of air dry *Dendrocalamus* and 75 of *Bambusa* to a ton. The length of each piece has not been specified by the two latter officers. M. G. Venkatarao based his calculation of yield on the figures of enumeration obtaining in the report drawn up by Eagles in 1935.

General remarks on the management of bamboo areas in Indian States.

The different methods of management of *Dendrocalamus strictus* in the various States of India are described hereunder in brief with special reference to past and current experiments. The data do not admit of any certain conclusions but it is generally established that some mature culms should be left in addition to all immature culms at each felling, that the felling should be distributed as evenly as possible over the clumps and that the felling cycle may vary from 1 to 5 years according to growth conditions and methods of working.

The following information has been gathered from the Indian Forest Record on the subject of P.N. Deogun and from working plan reports of various States.

Madras.—Bamboo is either sold to contractors standing or given on permits. Out of 19 working plans studied by Deogun, 17 prescribe, according to him, a felling cycle of 3 years and two of four years. In the Working Plan of Chittor division by V.S. Krishnaswamy, I.F.S. published in 1941 and in the Vellore East Working Plan by A.R. Brand published in 1939, which probably were not available at the time of writing Deogun's Indian Forest Record, a felling cycle of 3 years has been prescribed. Treatments vary; in 5 divisions the treatment is left to the descretion of the divisional forest officer; in others, 5 *to* 10 *mature culms are prescribed to be left per clump in addition to all new ones,* and in yet others it is prescribed that all new culms plus a number of mature culms *equal to or twice the number of new culms* must be left; in such cases a minimum of 6 culms to be left per clump has also been prescribed. In one division, all new plus half the mature culms have been prescribed to be left per clump at each felling. The Working Plan of Vellore East division of 1941 also prescribes that in addition to new culms a minimum of at least 6 old culms should be left.

Bombay.—The felling cycle in those divisions which have a Bamboo working circle is 3 years, and it is prescribed that all new culms plus a proportion of the mature culms should be left. In the Thana Working Plan of 1917 *the leaving of at least one-third the number of green culms* (including the new ones) in each clump is prescribed. Bamboo is exploited on a permit system, or is sold to contractors by coupes for a lump sum.

Madhya Pradesh.—Bamboo is exploited as in Madras. In the old working plans, clear-felling on a 3-year felling cycle of all culms except the new ones was prescribed. In the Bilaspur Working Plan of 1912 a proviso was made that *not more than half of the green culms in a clump should be felled.* This was found unworkable as the clumps were found to be deteriorating under a cycle of 3 years and so in the newer working plans for Balaghat—1932-42, North Chanda—1927-57, Seoni—1929-39, N. and S. Raipur—1928-29, *a cycle of* 4 *years and leaving of all new plus a definite number* (8-12) *of old culms* if prescribed. Felling at a height of 6-12 inches (18 inches in the case of congested clumps only) is recommended.

Punjab.—Bamboo is exploited departmentally on a 2-year felling cycle and the yield is fixed by area (W.P., Kangra division, 1932). The maximum number of shoots cut in a clump must not exceed the total number of new plus one year old shoots (*i.e.*, the total production of the two preceding seasons).

Uttar Pradesh.—Bamboo is sold by coupes to contractors. A felling cycle of 7 years with removal of all except the new culms is generally prescribed. An older prescription for leaving 6 old culms in addition to the new ones on a 3-year felling cycle was never carried out by the contractors. The felling cycle was therefore raised to 4 years without any proviso as to the leaving of old culms along with the new ones. The first felling rules made by D. Brandis in 1883 made it essential for the contractors *to leave at least* 4 *growing culms in a clump.* The first bamboo working scheme by B. B. Omaston of 1890-91 introduced a 2-year felling cycle. This was found too short and therefore raised subsequently to 3 years. Retention of some mature culms along with the new ones was tried but this could not be enforced in practice. The present system therefore is one of a 4-year felling cycle without any restriction of leaving of older culms along with the new ones; but

deterioration is apparently still in progress according to Deogun.

General results of working bamboo forests.

Departmental working—

This is found only in Punjab. Here the number and class of bamboos to be felled each year from the annual coupes will depend upon the demand which is estimated by the District Forest Officer by small advance sales. The felling men are allowed to cut in coupes with instructions to bring out a certain class of bamboos—a well understood classification being prevalent—which the felling men know by years of training and experience. When the desired quantity of the class of bamboo in question is received in the depot the cutting of that class is stopped. The men are paid by the department on contract rates according to the class of bamboo cut. The cutters, as usual, will not handle congested clumps or clums which are difficult to cut. Therefore, cleanings are prescribed to precede thinnings so that all culms are made workable, but their advantage is lost in clumps which are left unworked for want of demand for the class of bamboo they can yield. The fellings have thus *depended more on the demand than on what the clumps can yield.*

Working through the agency of contractors by permit holders.—A casual inspection of the bamboo forest worked almost anywhere in Mysore will probably show that if, in some places, the clumps are overworked in others they are very lightly felled or even not worked at all. Overworking is very common near villages or along main roads leading to centres of heavy consumption, and those of light working in forests of inaccessible areas, difficult ground or having a long lead, or where the demand is less than the available quantity. The felling rules and prescriptions are often ignored. If leaving a certain number of old culms along with the new ones is prescribed, then none or only such culms as are not saleable are left. *The felling men are only concerned in cutting what pays them best, and so too the contractor in having that cut which finds a ready market or satisfies the requirements of the consumer.*

When clearfelling of all except new culms is prescribed then actually only such culms as are saleable and out of the unsaleable only such as get in the way of the cutters are cut. Under a clearfelling system this is not of much consequence as the advantages and disadvantages are more or less balanced. Whereas the inferior culms left provide some food to the rhizome and support to the new culms, they also make future working difficult and increase the danger of insect attack and fire.

Not much regard is paid to cutting with one or a minimum number of sharp cuts, leaving old culms scattered evenly all over the clump base, or non-removal of culms round the peripherry.

Silvicultural improvement.

General.—Before the advent of the Paper Mills at Bhadravati (Mysore) the demand for bamboo was insignificant compared to the large stocks available, and it was therefore not considered necessary or justifiable to undertake any cultural operations involving expenditure for them. On the other hand it was felt that bamboos have been unquestionably doing considerable damage to the more valuable timber species by restricting their growth and preventing their spread. Periodically, after each wholesale flowering and death, the devastating fires which followed this event spread destruction and ruin to the valuable forest trees. Bamboo growth has therefore been looked upon by many forestmen as the enemy of the tree growth. With the advent of the Paper Mills, however, this view has considerably changed in favour of bamboo.

The following extract from the working plan of the forests of Bhadravati division prepared by the writer in 1936-37 (page 52) sums up the general opinion which then existed as regards bamboos :—

> "Owing to the limited market for them, bamboos have hitherto been regarded more as a weed in our plantations and inaccessible parts of natural forests. The effect of bamboo in the mixed-deciduous forest is to occupy the greater portion of the ground to the exclusion of natural regeneration of timber trees. Fierce fires almost invariably follow the death of bamboos and cause serious damage to large timber trees and often completely exterminate any existing regeneration. The canopy is left open for some years after the death of bamboo and weeds, creepers and annuals cover the ground".

> "**Advantages of bamboo.**—Occasionally the bamboo seeded areas from excellent

beds for the seedling regeneration of valuable timber species. Patches of *nandi* (*Lagerstroemia lanceolata*) in its pole stage about 30 years old which have been formed in this manner may be seen in the Lakkavalli forest. In clearfelling and regenerating an area, the presence of bamboo ensures a good burn. It is also noticeable that timber which is grown along with bamboo has often cleaner, straighter and better grown boles than that grown without it."

"The introduction of the plant for the manufacture of Paper Pulp at Bhadravati has changed the entire aspect of forest utilisation with regard to bamboos. From their subordinate position as an unimportant and often unrequired adjunct to the forest crop they have now risen to the rank of the most important raw material for a thriving industry. Their silvicultural requirements and other factors connected with their growth and development are now the subject of nearer study and closer observation."

Experimental Work on Dendrocalamus Strictus and Bambusa arundinacea

Moisture content of the bamboos.

To ascertain the percentage of moisture in green bamboos, and the time taken for green bamboos to become air dry during different seasons of the year, the following elaborate experiment was carried out. From 1st July 1936, ten culms of *Dendrocalamus strictus* and two of *Bambusa arundinacea* were collected every day for a period of one year up to end of June 1937. The bamboos collected each day were weighed at intervals of one month till the weight remained nearly constant. The experiment was conducted in two localities, Joldhal and Kodihalli, representing the dry and the semi-moist types of forests. The following statement gives the weight of bamboos collected in the diffrrent months till they became air dry. They were all stacked in the open and not under shade to correspond to the conditions prevailing at the tramway sidings where the bamboos are generally kept before their final transport to the Paper Mills.

Month of collection.	Month of weighment.	WEIGHT IN PERCENTAGES.			
		Dendrocalamus strictus.		*Bambusa arundinacea.*	
		Kodihalli.	Joldhal.	Kodihalli.	Joldhal.
July, 1936	July 1936	100	100	100	100
	Aug. "	87	94	95	94
	Sep. "	70	84	74	90
	Oct. "	70	73	64	78
	Nov. "	64	64	63	68
	Dec. "	63	61	62	64
	Jan. 1937	63	58	60	64
	Feb. "	63	58	60	64
August, 1936	August 1936	100	100	100	100
	Sept. "	87	92	84	87
	Octr. "	72	78	73	72
	Novr. "	67	69	64	65
	Decr. "	64	63	60	59
	Jan. 1937	63	60	56	54
	Feb. "	63	60	56	54

Month of collection.	Month of weighment.		Weight in percentages.			
			Dendrocalamus strictus		*Bambusa arundinacea*	
			Kodihalli.	Joldhal.	Kodihalli.	Joldhal.
September, 1936	Septr.	1936	100	100	100	100
	Octr.	"	80	91	91	79
	Novr.	"	70	71	70	66
	Decr.	"	68	64	63	60
	Jan.	1937	63	59	63	58
	Feb.	"	62	58	63	56
	Mar.	"	62	58	63	56
October, 1936	Octr.	1936	100	100	100	100
	Novr.	"	87	81	85	76
	Decr.	"	76	69	76	65
	Jan.	1937	71	61	71	65
	Feb.	"	68	58	68	59
	Mar.	"	67	58	68	59
November, 1936	Novr.	1936	100	100	100	100
	Decr.	"	82	79	93	76
	Jan.	1937	76	63	82	64
	Feb.	"	64	57	71	63
	Mar.	"	62	54	68	62
	April	"	62	54	68	62
December, 1936	Decr.	1936	100	100	100	100
	Jan.	1937	86	71	85	71
	Feb.	"	62	63	72	63
	Mar.	"	58	55	64	55
	April	"	58	55	60	55
	May	"	58	55	60	55

Month of collection.	Month of weighment.		WEIGHT IN PERCENTAGES.			
			Dendrocalamus strictus		*Bambusa arundinacea*	
			Kodihalli.	Joldhal.	Kodihalli.	Joldhal.
January, 1937	Jan.	1937	100	100	100	100
	Feb.	,,	70	71	82	71
	Mar.	,,	62	61	67	59
	April	,,	60	57	66	57
	May	,,	60	57	66	57
February, 1937	Feb.	1937	100	100	100	100
	Mar.	,,	72	65	66	66
	April	,,	65	59	64	62
	May	,,	65	59	64	60
	June	,,	65	59	64	60
March, 1937	March	1937	100	100	100	100
	April	,,	70	68	80	63
	May	,,	69	65	73	60
	June	,,	69	65	66	58
April, 1937	April	1937	100	100	100	100
	May	,,	73	66	75	66
	June	,,	65	64	70	64
May, 1937	May	1937	100	100	100	100
	June	,,	80	67	91	72

The average for ten months from July 1936 to April 1937 work out as follows:—

Percentage of air-dry bamboo weight to the weight of green bamboo collected.

	Dendrocalamus strictus	*Bambusa arundinacea*
	%	%
Kodihalli	63	64
Joldhal	59	59

From the above it can be seen that the moisture contents do not show any appreciable variation between *Bambusa arundinacea* and *Dendrocalamus strictus.* For bamboos in Kodihalli the moisture content is 36 to 37 per cent against 41 in Joldhal.

In the rainy season the bamboos take approximately 4 months to become air dry, and this period gets reduced to 3 months in the cold weather and two months in summer. The loss of moisture is greatest during the first month. The moisture content is less in summer than during other months. The difference in moisture content between air dry and green bamboos may be taken at 40 per cent for the whole area under consideration.

Number of bamboos per ton .—

The weight of air dry bamboos consisting of entire culms of all sizes has been estimated by M. V. Narasimhiya and C. H. Eagles as follows:—

	M. V. Narasimhiya	C. H. Eagles.
Dendrocalamus strictus	300 per ton.	*250 per ton.
Bambusa arundinacea.	75 per ton.	75 per ton.
Oxytenanthera monostigma	600 per ton.	..
Oxytenanthera stocksii	300 per ton.	..

* 18 feet cut lengths, air dry, and not whole bamboos.

Both Eagles and Narasimhiya have overlooked the fact that bamboos vary widely in size in the wet and the dry zones, and the figures are therefore correct only for a particular locality. From the writer's experience it would probably be correct to take 300 bamboos as equivalent to a ton in the dry zone and 250 in the wet zone.

(*a*) Rate of growth of individual culms.

The rate of growth in length and girth of individual culms has been recorded by M. V. Narasimhiya. (Vide Pp. 342)

These measurements are, however, subject to various technical mistakes. The initial sizes of the culms measured and consequently their ages are different and it is incorrect to average the rates of growth of such culms, because the rate is different at different periods of a culm's life. Moreover, the rate of growth in length is influenced appreciably by weather conditions, *a sunny day followed by a warm night being most advantageous to growth.*

Measurements taken by the writer during the years 1937 to 1943 indicate the following trends in the rate of growth of *Dendrocalamus strictus*:—

(1) The rate of growth starts with a minimum, continues to increase till about the end of the 3rd week of emergence, remains at a high level till the end of the 8th week and slows down gradually, and falls to about one-half the original rate by the 10th week and comes to a close by about the end of the 12th week.

(2) The rate of daily growth is subject to severe flunctuations, *sunny days accompanied by warm nights being the most advantageous. The elongation is greater by night than by day.* The weather of the *previous* day influences the rate of growth, not that of the day on which the growth is actually recorded.

The behaviour of all kinds of bamboo with respect to the above is almost the same.

RATE OF GROWTH

No. of shoots	29th August, 1918.		30th August, 1918.				31st August, 1918.		
	At 6 P. M.		At 6 P. M.		At 6 P. M.		At 6 P. M.		At 6 P.
	length.	girth.	length.	girth.	length.	girth.	length.	girth.	length.
									Dendrocal
1.	26 1/2	8 3/4	29 1/2	8 3/4	29 1/2	8 3/4	35	8 3/4	38
2.	20 1/2	8 1/4	23 1/2	8 1/4	24	8 1/8	27	8 1/4	28 1/2
3.	14 1/2	7 1/2	15 1/2	7 1/2	16	7 1/2	18	7 1/2	19
4.	14	7 1/2	15	7 1/2	15 1/2	7 1/2	17 1/4	7 1/2	18 1/2
5.	17	7	19	7	20	7	23 1/2	7	24
6.	9	5 1/2	10	5 1/2	10 1/4	5 1/2	11 1/2	5 1/2	11 3/4
									Bambusa
1.	15 3/4	6	16	6	16 1/2	6	17	6	17
2.	40 1/4	8 1/2	43	8 1/2	44 3/4	8 1/2	48	8 1/2	50
3.	7 1/2	3	7 1/2	3	7 3/4	3	7 3/4	3	7 7/8
4.	41	10 1/4	44	10 1/4	46	10 1/4	56	10 1/4	52
5.	64 3/4	3 1/2	67 1/2	3 1/2	69 1/4	3 1/2	73	3 1/2	75
6.	16 1/8	4 1/8	19	4 1/8	19 1/2	4 1/8	22	3 1/8	23 1/2
									Oxytenanthera
1.	41 1/8	4 1/2	44 1/2	4 1/2	46	4 1/2	50	4 1/2	51
2.	12 1/2	4	13 1/2	4	14	4	15	4	15 3/4
3.	28 1/4	4 1/2	30 3/4	4 1/2	31	4 1/2	34	4 1/2	35 3/4
4.	28 3/4	4 1/4	31	4 1/4	31 1/4	4 1/4	34	4 1/4	35
									Oxytenanthera
1.	69 3/4	3 7/8	75	3 7/8	77	3 7/8	82	3 7/8	84
2.	19 1/4	4 1/2	19 3/4	4 1/2	19 3/4	4 1/2	19 7/8	4 1/2	19 7/8
3.	20	4 1/2	20 1/2	4 1/2	20 1/2	4 1/2	20 5/8	4 1/2	20 5/8
4.	10 1/4	3 1/4	10 1/2	3 3/4	10 1/2	3 3/4	10 5/8	3 3/4	10 5/8

OF BAMBOOS.

M.	1st September, 1918				2nd September, 1918		Average day growth.	Average height growth.	Remarks.
	At 6 P.M.		At 6 P.M.		At 6 P.M.				
girth.	length.	girth.	length.	girth.	length.	girth.			
amus strictus									
8 3/4	42	8 3/4	44 3/4	8 3/4	49 3/4	8 3/4	1 11/12	4 3/8	29th Aug., 1918, day cloudy.
8 1/4	32 1/2	8 1/4	34 1/8	8 1/4	37 1/4	8 1/4	1 15/24	3 11/32	29th Aug., 1918, night misty.
7 1/2	21 1/2	7 1/2	22 1/8	7 1/2	23	7 1/2	17/24	1 19/32	30th Aug., 1918, day Sunny.
7 1/2	21	7 1/2	21 3/4	7 1/2	23 1/8	7 1/2	5/6	1 21/24	30th Aug., 1918, night no rain.
7	27 1/2	7	29 3/4	7	33 3/4	7	1 1/4	3 1/8	31st Aug., 1918, day sunny.
5 1/2	13 1/4	5 1/2	13 1/2	5 1/2	14	5 1/2	1/4	1 1/12	31st Aug. 1918, night no rain.
					Average height growth of a culm in 24 hours : 3 85/144″.				
arundinacea									
6	17 1/2	6	18 1/2	6	18 7/8	6	1/2	3 8	1st Sept., 1918, day rainy.
8 1/2	53	8 1/2	54 1/2	8 1/2	56 1/4	8 1/2	2 3/4	1 3/4	1st night misty.
3	8	3	8 1/4	3	8 3/8	3	1/16	5/24	2nd Sept., 1918, day sunny.
10 1/4	56	10 1/4	57 3/4	10 1/4	61 1/2	10 1/4	3 11/16	1 11/12	
3 1/2	79 1/2	3 1/8	81 3/4	3 1/2	85 1/4	3 1/2	3 5/8	2	
4 1/8	29	4 1/8	30 1/4	4 1/8	34 3/4	4 1/8	3 27/32	1 1/12	
					Average height growth of a culm in 24 hours : 3 365/576″.				
monostigma							Average Night	Growth Day	
4 1/2	55	4 1/2	56 1/4	4 1/2	59 1/8	4 1/2	3 9/16	1 1/4	
4	17 1/2	4	18 1/4	4	20 1/8	4	1 13/32	2/3	
4 1/2	39	4 1/2	40 1/2	4 1/2	43 1/4	4 1/2	2 7/8	1	
4 3/4	38	4	39 1/4	4 1/2	11 1/4	4 1/4	2 9/16	5/6	
					Average height growth of a culm in 24 hours : 3 223/284″.				
stocksii									
7 7/8	90	3 7/8	91 1/2	3 7/8	95 3/4	3 7/8	5 3/8	1 5/6	
4 1/2	20 1/2	4 1/2	20 7/8	4 1/2	21 1/4	4 1/2	13/12	1/3	
4 1/2	21	4 1/2	21 1/2	4 1/2	4 7/8	4 1/2	13/32	1/4	
3 3/4	11	3 3/4	11 1/4	3 3/4	11 1/2	3 3/4	1/4	1/12	
					Average height growth of a culm in 24 hours : 2″				

(b) Rate of production of culms in clumps.

M. V. Narasimhiya gives some statistics on the above subject which is the most important for the determination of yields. The following statement shows his figures .—

State forest.	No. of culms 1 year old.	No. of culms 2 years old.	No. of living culms 3 years and more old.	No. of dying culms.
Dendrocalamus strictus				
Kakanhosudi	2 3/4	2 1/2	15 1/2	2 3/4
Umblebyle	1 1/3	4	11 1/2	1
Chornedehalli	5 1/2	8	18	2 1/4
Aldhara	2 3/4	2 1/2	15 1/2	2 3/4
Lakkavalli	2 1/2	3 1/4	11 1/4	1 1/3
Hebbagiri	2 1/3	3	12	1 1/4
Tegurgudda and Waddihatti ..	1 1/3	2	10 1/2	2/3
Muthodi	1 1/2	2	11 1/4	3/4
Aramballi	2 1/2	3 1/3	16	3 2/3
Bambusa arundinacea				
Lakkavalli, Sakrebyle, Muthodi, Tegurgudda and Hebbagiri.	1	2/3	9	3/4

Older experimental work on bamboo exploitation in various Indian States.

MADRAS

The following result was obtained by K.R. Venkataramiyer after a 8-year field experimental work as regards the best felling cycle conducted in Komatiyeri reserve, Polur range, South Vellore division, in 1917. The plot occupied a locality with an elevation of 2,300 ft. and a rainfall of 45 inches.

Method of treatment.	Expt. number.	Felling cycle years.	Average No. of culms produced each year.	Total No. of culms produced each year.	No. of new culms available for felling.
100 per cent cutting of culms over one year old.	1	2	2	4	2
	2	3	2	6	4
50 per cent cuttings of culms over one year old on one side of the culmps.	3	4	1½	6	4½
	4	2	2	4	2/2=1
	5	3	4	12	8/2=4
	6	4	3	12	9/2=4½
50 per cent cuttings of culms over the whole clump	7	2	4	8	4/2=2
	8	3	4	12	8/2=4
	9	4	5	20	15/2=7½

Average annual yield per clump in culms.

1	Harmful effect on clumps; many died after ten years; culms of poor quality.
1½	Culms better than in expt. 1 and clump healthier.
1½	Clumps died early.
½	Clump long lived and healthy; clump not much damaged.
1 1/3	Clumps healthy.
1 1/8	Clumps healthy.
1	Clumps not healthy.
1 1/3	Clumps healthy.
1 7/8	Clumps healthy.

Longevity of culms.

Felling cycle.	*Maximum.*	*Minimum.*
2 years	12 years.	4 years.
3 years	Less than 12 years.	4 years.
4 years.	Do.	Less than 4 years.

P. N. Deogun has stated that it is not possible to derive any conclusive deductions from the experiment owing to various experimental mistakes but, it may be said that a cycle of 3 or 4 years is better than 2 years if half the mature culms are left.

Punjab—E.P. 1 and 3, Hoshiarpur division.

To study the effect of different felling cycles, *viz.*, 1, 2 and 3 years on the production of new shoots, both in quantity and quality, two plots were laid out in Karanpur pure bamboo forests in 1916 and 1919: altitude 1700 to 1900 feet, average rainfall 67". The average percentage relation of superior class new culms to the total culms produced by individual culms during the 10 years of the experiment have been recorded by Deogun as follows, standard error being given .—

Felling cycle	1	2	3 years.
Plot 1.	5.5±2.28	7.8±3.64	15.3±5.72
Plot 2.	1.51±6.29	6.52.±57	10.4±3.42

The differences between cycles with their standard errors are .—

Plot No.	Difference between 2 years and 1 year cycles	Difference between 3 years and 2 years cycles	Difference between 3 years and 1 year cycles
1	+2.3±4.3	+7.5±6.78	+9.8±6.16
3	−8.6±6.8	+3.9±4.28	—4.7±7.16

In no case is there a significant superiority of one over the other, as none of the differences even approaches twice the error.

Damtal, Kangra division.

The folowing results prepared from figures given in the Indian Forester, 1931, pp. 552, 553, have been recorded by Deogun .—

Felling Cycle.	No. of culms at the commencement	Production in 6 years.				Useless culms.
		Useful culms.				
		Class I.	Class II.	Class III.	Total.	
1.	206	33	260	120	413	22
2.	208	60	321	89	470	49
3.	232	34	313	63	410	20

On the basis of these figures N. P. Mohan advocates a 2-year felling cycle for bamboo. It is stated that as there was no initial comparability and as the method of working was different in the three cases and moreover as the experiment was continued for 6 years only, no definite conclusions can be drawn from these experiments.

UTTAR PRADESH.

The experiments conducted in the Forest Research Institute, Dehra Dun, which were first initiated by Troup and carried on by E. Marsden and H. Trotter lead to the following results:—

(1) **Clearfelling the clumps of all culms, new and old.**—This was found to result in killing the clump or its deterioration and consequent need of a great number of years to regain its original condition.

(2) **Felling of all culms except those of the previous rains in a clump.**—This, according to Deogun, results generally in very low production of new culms, and the new culms also tend to fall over.

(3) **Felling of half the culms more than one season old in a clump.**—This gave better results than clearfelling the clump or felling of all culms more than one rains old, but was in no way encouraging.

(4) **Cutting at different heights.**—On the whole very low cutting is not to be recommended. Cutting low gave poorer results, both in the survival per cent and production of new culms, than higher cutting —3 to 5 nodes.

(5) **Effect of felling cycle.**—Three and 4-year felling cycles' were tried only with clumps worked under felling of all except new culms. In this case it was found that the longer the felling cycle the better the production of culms and the condition of the clumps obtained.

E.P. 5. SAHARANPUR DIVISION.

Another experiment to study the effect of (i) felling cycle of 2, 3, 4 and 5 years, (ii) cutting of half the culms of more than one season old or leaving a number of old culms equal to twice the number of new shoots, or equal to the number of new shoots, or a fixed number *viz.*, 3, 5, 7 and 9, and (iii) cutting at two different heights, on the development and production of bamboo clumps.

There was no initial comparability between the clumps. Only 3 clumps were marked under each treatment.

RESULTS.

Height of cutting.—Under a 2-year cycle the clumps cut above 5 nodes showed a significant superiority in the production of culms over those cut above one node ; under a 3-year cycle the superiority still remained but was not significant ; under a 4-year cycle the superiority changed into inferiority but without significant difference.

Felling cycles.—A 3-year cycle gave superior results to those of 2 and 4-year cycles, with a significant difference over the 2-year cycle only.

Common defects of older experiments.

Among the defects listed by Deogun are—lack of initial comparability, use of too small a number of clumps per treatment, non-randomising of clumps, absence of record of size or quality of culms produced, want of check of unauthorised fellings which ruined some experiments, introduction of abnormal conditions by cutting overhead cover at a later stage, defective maintenance of records and dissimilar felling rules for clumps under different treatments.

THE NEW EXPERIMENTAL WORK.

(*a*) Experimental work in Indian states.

Since 1931 new experiments have been initiated in different states and investigations have been going on co-operative lines in Madhya Pradesh, Madras, Orissa, Punjab and Uttar Pradesh. The study aims at finding the effect of different felling cycles (2 to 5 years) and treatments (retention of n, 2n, 8 or $\frac{1}{2}$ of total) on the production and quality of culms (where n=number of new culms). The data available after some years will be of the following kinds:—

(i) Average number of new culms (by different classes or general averages) produced per clump per annum.

(ii) Average number of mature and useful culms exploited, and left, in each clump at the time of working up results, per annum.

(iii) Average number of useless culms removed and left in the clump at the time of working up the results, per clump per annum.

The chief defect of this experiment is that the number of old culms retained—n, 2n, 3n, etc., will depend upon n, (the number of new culms of the year of felling) which is sometimes very variable ; it will be very high in the year after every moderate felling and will vary otherwise with the annual rainfall and its distribution.

In favour of the above system it has been stated that treatments based on the number of mature culms in a clump are impracticable for the reason that after the fellings there can be no check that the prescriptions have been followed. In Mysore, on the other hand, even this has been found to be no safeguard because some of the new culms are also cut and removed ; thus " n " becomes unreliable in the check.

Experimental work on Dendrocalamus strictus in Mysore.

It was decided in Mysore to study the effect of different intensities of felling on the number and quality of new culms and therefrom derive the most suitable felling cycle and the most favourable felling intensity.

Experimental plots were laid out in carefully selected areas, accessible, with labour facilities, where bamboo showed average good growth for the localities but had least danger of damage by villagers or wild animals, on easy slopes or ground with good drainage with more or less the same aspect, with fairly young, compact and healthy bamboo clumps of average quality and with more or less uniform shade conditions.

In experimental plots 1 and 2 the felling intensities were randomized over the whole plot, no sub-plots having been made, but in E. Ps. 3 to 5 the felling intensities were kept to different sub-plots, the treatments being uniform in each. This was done because it was found that the practical difficulties in carrying out the felling and recording if the intensities were randomized within the sub-plots involved a risk disproportionate to the advantages obtained.

After the selection of plots suitable clumps were selected and numbered—exceptionally big or small or congested clumps having been rejected—cleanings, consisting in the removal of all culms which were dead and dry, cutting climbers etc., were carried out in all clumps except in those earmarked for study as uncleaned clumps. Culms of one season and those of more than one season were recorded separately.

The experimental work was carried out to arrive at conclusions as regards .—

I. Main Investigations.

(i) The longevity of culms.

(ii) The numerical ratio between the number of existing culms (old and new) and the average annual production of culms.

(iii) The numerical ratio between the number of culms which die annually to the number of culms existing.

(iv) Felling intensities and their reactions upon (a) the number of new culms (b) condition of new culms classified under—*normal*, *switchy*, *underdeveloped*.

(v) The most suitable felling cycle under local conditions.

(vi) The most advantageous felling height under local conditions.

(vii) The influence of overhead forest cover on the growth of the bamboo.

II. Subsidiary investigations.

(i) Effect of burning.

(ii) The effect of cleaning clumps on the production of new culms.

(i) **The longevity of culms :—**Each year's culms were indicated by a different letter of the alphabet starting with those of 1935 which have been labelled " A ". Thus those of 1943 were labelled ' I '. Every year, in winter, all the clumps were inspected, the new culms marked with the appropriate letter of the alphabet, and the number of dead culms with the letters found were recorded. If possible, a check of the older culms was also made. If a clump was found in flower a note to the effect was made but the recording was continued till it was completely dead.

(*ii*), (*iii*) and (*iv*) Numerical ratio between the existing numbers of culms and those that are produced or die each year and reaction of felling intensities upon culm formation :—

FORM.

1935		1936									1937				1937 continued					
								fellings			Number produced during the year.					Number dead during the year.				
No. of culms at the beginning of the experiment, 1935.	No. of culms of the year 1935. (A)	Total.	No. of culms at the beginning of 1936.	No. produced during the year. (B)	No. of dry culms removed.	Closing balance.	Opening balance.	Percentage	Number.	Number left.	Normal.	Switchy.	Underdeveloped.	Total.	Grand Total.	Older than. (A).	(A).	B., etc.	Closing balance.	Remarks.
1	2	3	4	5	6	7	8	9a.	9b.	10	11a.	11b.	11c.	11d.	12		13		14	15

For this purpose the number of culms produced annually and those that die annually was recorded ; against the former were noted whether the culms were (1) *normal* (2) *under-developed* (3) *switchy*, and against the latter the year of their formation as indicated by the letters of the alphabet. *Normal* culms are those of the *average size in the clump under consideration* ; *under-developed* are those which are *appreciably undersized* while by switchy culms are understood those which have a whippy, thin, elongated body and undeveloped branches with crowded up, dimunitive leaves suggesting a witches-broom.

(*v*) **Suitable felling cycles :—**This is indicated *by the time* (*number of years*) *taken by clumps felled under various felling intensities to regain their original conditions* (*i.e.*, condition at the time of felling) as regards both the number of culms and their size. For example, if a clump with 100 culms thinned up to 50 per cent in 1935 regains the original number of 100 culms of normal size in the 4th growing season after the felling (*i.e.*, in 1939), such a clump can be worked again in the 5th year (1940) to the same intensity (50 per cent) provided the culms produced in the season immediately following the felling (in this case in 1936) are generally all *normal*, (*i.e.*, not undersized or switchy).

(vi) **The most advantageous felling height :—**In one plot, E.P. 2, culms were cut at three different heights (1) *flush with the ground*, (2) *knee high*, *i.e.*, 2 to 3 internodes high and, (3) *waist high*, *i.e.*, 4 to 5 internodes high, under the different felling intensities 100% (clearcutting) 75% and 25%. The results observed on the number and condition of the new culms were recorded separately under the heads— *normal*, *underdeveloped* and *switchy*.

(vii) **The influence of the overhead forest cover :—**In E.Ps. 3 and 5 the overhead forest cover was removed by girdling all the trees, the thinning intensity experiments repeated and the results recorded exactly as in the other experimental plots.

The following forms were adopted for recording the numerical and other data.

(See opposite page)

(To be continued)

CHARCOAL BURNING IN SWEDEN.

By R. M. Singhal, M.Sc., B.Sc., (Edin.)

Sub-Divisional Forest Officer, Allapalli, Madhya Pradesh.

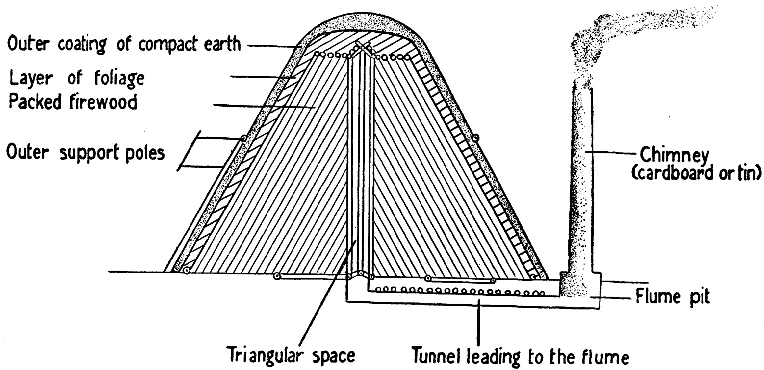
(These notes were taken at the charcoal burning school near Skinskateburg (in August 1947) where I had the privilege of joining Professor H. G. Champion who was on tour with the officers on Refresher Course).

Charcoal in burnt extensively is Sweden in areas away from paper factories or wood distillation plants and where means of communication are not easy or cheap. All the species in Sweden of which there are very few are used for this purpose. The most common species used are—Sitka spruce—*Picea sitkensis*, Scotspine—*Pinus silvestris* and two or three species of *Betula* (birch).

Sweden is famous for her advanced practice of Forest Management, timber trade and forest industries such as, plywood, paper manufacture, wood distillation, charcoal burning, etc. Most of the small thinned material and small branch-wood is either used for paper pulp or for wood distillation, but in remote areas which are far away from these industries and where means of communication are not easy or cheap, the small stuff is burnt in the forest to make charcoal.

A patch of about an acre of flat land is cleared for making the kiln. The best ground is that which is highest in the centre, is well set and slopes gradually on all sides to facilitate easy run out of the tar.

The kiln is cone shaped a with rounded top, 3 metres high and 6 metres in diameter at the bottom. Stacking is done of fuel wood all round a central core consisting of stout poles which are arranged so as to enclose a central triangular space of 60 cm. sides (60 cm. each side). (See Fig.) Firewood billets 1 to 4 metres long and 5-15 cm. in diameter are generally used. Stouter pieces and hardwoods are piled in the outer half of the kiln where there is more heat. A few stout poles



DIAGRAMMATIC MEDIAN LONGITUDNAL SECTION OF THE KILN .

R.K. Sharma
1951.

are arranged radially as well as in concentric rings on the ground and secured to the ground with pegs which prevent the whole super structure from sliding down.

After the piling is over, it is covered with spruce foliage 20-25 cm. thick, in absence of which even tree moss or waste paper or newsprint is used. On this a coating of ash or fine earth about 30 cm. thick is packed after which it is allowed to set by moistening with by a spray of water. The outer slope of the completed kiln will be about 60°. The outer surface of the kiln is then consolidated with a wooden club to make the covering compact thus preventing undue access of the atmospheric air. The capacity of a kiln whose dimensions are given above will be 100 cb. m. Kilns up to 300 cb. m. in volume are also made.

The stacking is so done as to provide circulation of air within the kiln. A pit 50 cm. × 50 cm. and 50 cm. deep is dug outside the kiln and adjoining it, and this is connected with the central open triangle of the kiln by excavating a channel between them. A square chimney of tin or thick cardboard about 1½ ft. high sides and about 2½ ft. high is placed on the pit. When the structure is complete, except the chimney, the kiln is lighted from the triangular opening at the top of the central core after which this opening is closed. Then some fire is put in the pit at the bottom of the flu to start air circulation within the body of the kiln. After about half an hour when air circulation has been established the chimney is placed on the flu-pit to lead off all waste of gases into the air. It is kept there for about six hours by which time the bottom of the kiln gets hot, after which it is removed.

Burning is complete in about 10 days but the kiln is allowed to cool for a further period of 10 to 12 days before it is opened to remove the charcoal. It has to be watched day and night during the whole period. Openings in the kiln outer cover caused by the sinking of the wood due to carbonisation are closed by throwing wet earth to plug the hole and consolidating it with a club and a spray of water.

The yield of charcoal by volume is about 55% of the volume of firewood used. Therefore the yield from a 100 cb. m. kiln is 55.5 cb. m. of charcoal. The price of charcoal prevailing in 1947 was 126 Swedish Kroners per cb. m. (1 rupee = 1.31 Kroners) *i.e.*, kiln charcoal of a single 100 cb. m. kiln is worth about Rs. 5,200). The cost of labour used for burning is about Rs. 2,500.

The use of the chimney at the beginning of the burning provides for uninterrupted air circulation which ensures quick and even burning.

THE GROWING MENACE OF ASSAM-LOTA (EUPATORIUM SPP.) AND HOW TO COMBAT IT.

By J. N. Sen Gupta,

Deputy Conservator of Forests, Bengal.

Introduction

1. Those who are acquainted with conditions in the southern tracts of peninsular India must have known what a baffling problem the notoriously invasive weed lantana was a few decades ago, to agriculturists, foresters and land-owners, and, for that matter, to the administrators of Madras and its neighbouring states. There were enquiry commissions as well as mixed committee meetings of experts of various departments presided over by senior administrative officers; yet, no amount of executive orders and repressive measures could eradicate this pest. It was, however, found to be one of the best hosts of sandal plants, and natural regeneration of these came up profusely in lantana areas,—the only disadvantage being the severe fires to which the lantana areas were subjected.

2. This reference to lantana is not out of place as it helps to introduce the pest species under discourse, which is its counterpart in northern India, *viz.*, Assam-*lota*. This weed has lately assumed menacing importance owing to its vigorous colonisation over the sub-Himalayan plains and the foot-hills of the Indian dominion, as well as in the bordering States of Nepal and Bhutan. Both these 'die-hard' weed-species have certain common characteristics in respect of their habit of invading waste and fallow lands, pastures, abandoned villages or cultivation, and forests that have suddenly been opened out with no, or only a sprinkling of, canopy trees in the overwood. A close and dense canopy cannot foster the growth of Assam-*lota*, which is a strong light demander.

3. Pretty similar is the case with another menacing aquatic weed in Bengal and Assam, in particular. The romance of "Water-hyacinth" has attracted many a scientist and volunteer-organisation like the "Bratacharis", first to destroy the plant, failing that to make the most economic use of it. It is time we had discovered a kind of benevolent "atom-bomb" to eradicate these unwanted species, unless we can find some real use for them.

The species of Eupatorium and their distribution.

4. Assam-*lota* (*Eupatorium odoratum* or *E. conyzoides*) is a coarse perennial, often straggling plant, which belongs to the family compositae whose winged seeds are carried by wind far and wide during the months of February and March, when the ground is generally bare and burnt, and therefore offers a suitable germinating bed to the species to regenerate itself profusely. Once it has spread out its roots, it can withstand adverse factors, such as fire or grazing, the former owing to its evergreen and succulent shoots, the latter owing to its coarseness and unattractive odour.

5. The relatively favourable soil and climatic factors of the *tarai* and the *duars* offer ideal conditions for vegetative growth of multitudinous species of annuals and perennials, including grasses, climbers and many other species of weed which have to be reckoned with by land-owners, planters, agriculturists and foresters, who are entrusted with the care, maintenance and improvement of the lands and crops in their charge. An invasive weed, if not controlled in its initial stage—or nipped in the bud, so to say—either by burning, soil-working or intensive cultivation, is bound to pass from an endemic to the epidemic stage, when it will prove to be a serious menace as Assam-*lota* and water-hyacinth have now become in Assam and Bengal.

Historical back-ground.

6. As the name of Assam-*lota* would itself suggest, this pernicious invasive weed practically spread all over Assam, where it has long been a great menace to plantations, and the natural regeneration of timber trees in forests. It is reported to have been noticed for the first time in South Bengal in the districts of Chittagong and Chittagong Hill Tracts (Pakistan) in *jhum* areas and other waste-lands, having migrated from the borders of Assam and Burma, soon after the first Great War of this century (1914-18). The writer came across patches of Assam-*lota* in abandoned *jhum* during his first visit to that side and the Arakan hill borders, off the Sungoo and the Matamouri ranges, during 1926. When he visited the forests of Upper Assam early in 1937, he was struck with the siverity of invasiveness of this weed, which was locally known as *German-ban*, as it is reported to have migrated into Assam during the 1914-18 German-War! Why and how

Assam relayed it on to her neighbouring province and the state of Tipperah we need not bother about. But the exotic has so naturalised itself by taking a strong foot-hold in Bengal that she can no longer drive this pest back into Assam and return the compliments! Bengal has always been hospitable to pests, parasites and pestilence of sorts,—so why worry?

7. The year 1924-25 marked the advent of this species to North Bengal forests,—at least it was so recorded, as the following extract from the Annual Progress Report on the Forest Administration of that State for the year 1924-25 would show:—" Two weeds from Southern Bengal were noticed for the first time in North Bengal, water-hyacinth and Assam-*lota*, both in Buxa division. Owing to local conditions, it is not likely that either will give much trouble ". There was no report in the following year, though in 1926-27, it was recorded as follows.—" Assam-*lota* (*Eupatorium sp.*) is mentioned by the Chittagong divisions. It appeared two years ago in North Bengal and has been steadily spreading west-wards in waste places since. It is doubtful whether it is ever likely to menace properly tended forests or plantations". What a pious hope the prophets of those days had, but their prophesy was soon belied: During the next quinquennium (1927-32), the annual reports were silent on this matter in Northern Bengal, although it continued to be " troublesome in plantations owing to its rapid growth " involving " considerable expenditure in weedings and cleanings " in South Bengal, where " success or failure of plantations depended on the speed with which the introduced tree species could be induced to establish themselves " (*vide* Annual Reports of the period).

8. The growing menace of this pest was reported in 1932-33, when Assam-*lota* was " the greatest enemy to the success of plantations " in South Bengal, while in North Bengal it was also " invading the forest rapidly and became a pest in the Duars with the subsequent difficulty of establishing plantations". It was mentioned that experiments with cover crops had been started with a view to the suppression of this pest. The following years (1933-34) report did really bring home to all the seriousness of the problem, as the following extract from para 59 of the years's Annual Report would show:—" Assam-*lota* (*Eupatorium odorata*) is reported as spreading in plantations in both Buxa and Jalpaiguri divisions and in the former to be suppressing *khair* and *sissoo* regeneration in high forest. This weed was first noted in the east of our area (Raidak extension, Buxa Division) in 1925 and noted in the Annual Report for that year. Though it has not been serious to the west of the Tista yet, having only recently crossed that river, it has been seen this year in Tukria-jhar, the extreme western forest block near the Nepal boundary. It has thus taken only 9 years to cross the entire width of northern Bengal, a distance of almost exactly 100 miles. Its steady progress, inspite of such efforts as we could make to check it, has been watched throughout. Wherever found on forest land it has been eradicated as far as funds permitted ".

9. The later reports of the period between 1934 and 1940 naively referred to its being " pulled out by the roots and burnt as far as practicable ". During 1940-41, this species was reported to have been " a troublesome weed in young coppice and plantations, especially where the stocking was poor " in Dacca-Mymensingh Division, where it (locally known as *Phuljhuri*) was said to overrun " the area as soon as the old crop is felled and to smother up natural seedlings and the distantly spaced coppice ".

10. Although no recorded evidence is available for the last decade (since 1940-41), when activities of the provincial Forest Directorate were concentrated on War efforts and Post-war development schemes, the unchecked progress of Assam-*lota* has, meanwhile, assumed an importance that can no longer be kept in the cold storage. It has its use, however, as a cover crop in binding the relatively loose soil and checking erosion, especially where the ground has been rendered bare due to natural or biotic factors.

Control Measures.

11. Soil is never static, and the succession of species is a natural process that may eventually replace Assam-*lota* by more benevolent weeds, *e.g.*, *Berhavia hispida*, which is already coming up in some parts. It is a procumbent herb with often perennial roots of the family of ' Rubiaceae '. While nature, supplemented by fire-protection or otherwise, may effect such changes in a slow process, we must try and find some quicker methods by which we can turn the already infested large areas to some profitable use. In West Bengal the pressure of population has been very great and every inch of land must be fully utilised to grow more food.

In open pastures where Assam-*lota* has already been reducing the extent of grassy meadows

and in scrub-jungles or waste lands fit for re-introducing fodder grass and for cultivation respectively, it is suggested that all Assam-*lota* should be cut down, the slash allowed to dry up so as to be fully burnt *well before* the seeds mature and start flying about for dispersal, the soil deeply hoed or dug up by means of the plough or the tractor, and sown up with crops of the desired species, followed by proper and intensive cultivation year after year. This prescription is suggested for agriculturists, planters and land-owners.

The immediate concern of forest officers is to combat the invasion of Assam-*lota* in plantation areas, where growth of the prescribed species (like sal, *pyinkado*, *pucca-sal*, etc.) is too slow to form a close canopy,—say in two years—inspite of the best *taungya* method of plantation and one has consequently to fight against this pest which has a tendency to swamp or oust the desired forest plants soon after the harvesting of the *taungya* crop over the inter-spaces. Here, even the ideal *taungya* for two years is no panacea. The problem is not so serious with fast-growing species like *jarul*, *gamar*, *panisaj*, *lampati*, or, even teak, which have a tendency to close up the canopy in a couple of years.

No weeding or cleaning must be allowed to be done in any young plantations during the period between October and March,—as any breaking of the ground-cover during the cold weather would tend to invite Assam-*lota* which would soon form a tangled mass. The old system of introducing *Boga-medeloa* in the 2nd or 3rd year of sal plantations was good so long as the *Boga* continued to be properly tended and cut back. In its stead, jute or *arahar* may offer a suitable substitute which again is a profitable money (the latter being also a food) crop. All this would entail intensive cultivation with extra labour during the rains in particular, and the proper organisation of the labour to be sufficiently available at the right moment is the crux of the whole problem. It is now for us to offer a solution to this problem.

LAND EROSION *

BY SHRI B. S. SITHOLEY

ABSTRACT

SUMMARY

Control of erosion by Nature will prove ineffective unless human activities contributing to erosion are given up. The land has its limitations, and though its yield may be scientifically increased, the over-worked land is bound to go into decay. A symbiotic relationship, taking as well as giving, is essential between man and land. From the agricultural standpoint, erosion occurs through rain, rivers, frost, wind and sun. Cover of land by vegetation is the main single protective measure, involving creation of forest belts and growing of detached trees. Terracing, strip-cropping, and contour-ridging are essential. River erosion can be countered by strengthening river banks with soil-binding plants. Floods can be checked by diverting flood-water into escape channels, from which it can be gradually drained off. Over-grazing needs to be stopped, and the live-stock reduced in number. Other sources of food, not dependent on land, should be exploited, specially river fish. Fish is destroyed in large numbers by sewage and industrial wastes discharged into rivers. Manure contents could be extracted from sewage and profitable by-products recovered from industrial wastes.

Introductory.

Where not due to other causes, the decline of the great centres of ancient civilizations revealed to us by archaeologists was in all probability the result of erosion of the surrounding land. It is inconceivable that such cities were built and flourished upon the sand that now covers them. The land must have been fertile and productive at the time, with plenty of water and vegetation, and pasture-lands for cattle, goats and sheep which formed, along with agriculture, the primary factors in the economy of those civilizations. No major culture could exist without a sufficiency of food for the people and their domesticated animals. Cities spring up only from surplus wealth, and an impoverished land yields no surplus. Mohenjodaro in Sindh is a case in point. There is no evidence that internecine quarrels or foreign invasion, any epidemics or devastating flood, led to its abandonment, which appears to have been peaceful and gradual. This Indus-Valley city, with its spacious houses, temples, gardens, orchards, and open spaces, must have possessed a considerable population, and the demand on the land was great. That the crops raised by the citizens themselves were later found to be inadequate is evidenced by dried fish having had to be brought from the Arabian Sea coasts about 200 miles away to augment the food supply. Only the ultimate sterilization of land and consequent total failure of crops must have left no alternative to the people but to move out: erosion was thus responsible for the extinction of the earliest known civilization of India. If this is not incorrect, we at once see what tremendous power erosion possesses and how ruthlessly it can affect man's life.

Erosion, a natural process, is usually comparatively slow, but human agency often creates conditions which hasten its pace. Nature always maintains a balance; man, on the other hand, by reducing vegetative cover or altering the topography or soil upsets the balance completely. Deforestation, overgrazing, exacting demands on the land, and failure to put back into it as much as one takes out of it, sterilize fields and pastures that only a few generations ago were sound and richly productive. Before the advent of the British the land produced enough for home consumption, and perhaps a little to spare. But when the export of life-supporting commodities—the vital food-grains—began the aspect changed. The soil was forced to yield more than it could without getting debilitated, former agricultural methods being condemned as primitive, unprogressive and uneconomical. Seemingly so against the modern scientific technique, they were not without a certain wisdom: the land was never ploughed very deep, so that layers of soil still remained in reserve underneath; deep ploughing loosens and exposes them unnecessarily, and thus more soil is washed out by rain than would be otherwise. Whatever may be the gain in crop yield is more than counterbalanced by the loss of a good deal of productive soil: there is, therefore, a net loss on the whole by the land becoming progressively impoverished. This may not be immediately apparent, being

* A paper contributed to the Symposium "on the problem of land erosion" held in Poona.

effectively camouflaged by bumper crops, but in course of time the diminishing returns tell their own tale.

Export meant monetary wealth, and as long as money could flow in, in exchange for vital commodities, nothing else seemed to matter. This lopsided economics was encouraged by countries in need of agricultural produce, so with malproduction coupled with maldistribution, and on top an increasing population, the land was burdened to the point of being virtually crippled. And, meanwhile, erosion has been going on not only unchecked but considerably reinforced by money-making devices exceedingly injurious to the integrity of the soil. Forests have been cut down for timber export without the realization that, even if there was a surplus of timber, forests are so essential a factor in land conservation that actually many of them are at present very badly needed. Pasture land is allowed to be so completely grazed out, like hair machine-clipped to the skin, as to eliminate earth cover, and trampling by cattle crowded on to the same areas is rapidly converting the latter into waste lands. The almost exhausted soil, instead of being allowed to recuperate by natural means, is in the case of crop fields artificially fertilized; this fertilization is an immense economic liability, taken on a country-wide scale, for the results cannot always be commensurate with the expenditure involved. It is as if a man were kept going on drugs in opposition to his functioning in a state of sound natural health. Drugged, he may be able to make extraordinary efforts for a certain period, but the crash is bound to come sooner or later.

We are extracting more from the land than it should reasonably give, completely oblivious of the need of a symbiotic relationship, giving as well as taking. The land, like every other thing, has its limitations; and it is for science to explore other avenues with a view to producing synthetic food to meet the requirements of a growing population. Other food resources, independent of land, could also be exploited. Imagine a doubling or trebling of the present population (doubling has occurred in one hundred years), the land perforce remaining without any addition to it, more likely decreased by erosion, and you are faced with the problem of feeding that population from it. It simply cannot be done. About 110 million working farmers of India (before partition) raised food crops to support 250 millions in addition to themselves. Nearly 250 million acres are under cultivation, which works out to about three-quarters of an acre a head. The American standard of nutrition requires two and a half acres per head, that of other countries varying between this figure and one and a half, and this when all the scientific processes are applied to agriculture. How much then can we get out of three quarters of an acre, considering that the draught animals have also to be fed from the land? Our standard is low, first, because of shortage of land under cultivation; secondly, because tropical lands yield less than those of the temperate zones. The dream-ideal of producing two ears of corn where one grew before may, if realized, work for a time but will ultimately peter out. Science has placed wonderful power in our hands, but discrimination in its application is as much a survival need as a moral end. We should be able to see beyond the immediate for we have to pass on the land to our children and grandchildren. Undue exploitation of land will in due course mean at least permanently reduced standard of living hardly above that of a coollie, which would be tragic anti-climax to the plenitude implied in the transitory phase of two ears of corn. Man must stop being a parasite on land; all receiving and no giving will not pay.

Nature works unceasingly, and our business should be, with all the resources of science at our disposal, to control its destructive activities instead of allying ourselves with it against that which gives us sustenance. Unless we curb our greed and abandon ideas of false prosperity, fostered by academic economics, and cease thinking in terms of limitless exploitation and export of vital foodgrains, unless we give up abusing land, all efforts towards conserving it are bound to prove ineffective.

The Nature of Erosion.

Erosion is a process by which the land surface is being unceasingly worn down. If it were unchecked all land would eventually be reduced to sea level. It would be further eaten out and replaced by the sea, so that if no counteracting agencies, such as the slow upheaval of land in various regions, operated there would be no land left above water. Such eventuality is of course to be measured in geological time.

The eroding agents are rain, rivers, sea, wind, frost, glaciers, sun, and many burrowing animals. Unlike the Dutch in Europe, we in India need not worry about the sea. Nor about glaciers and burrowing animals, the activities of the latter being comparably almost negligible. The erosion of rocks, which produces sand and other detritus in various ways, cannot be checked, but such patches of

land on hill sides as contain productive soil do call for protection. However, if they are at the mercy of a wide scale and far advanced erosion there is no alternative but to hang on to them until driven out. Where no such danger exists and the control of erosion is practicable, preventive measures will be justifiable, provided the cost does not exceed the value of the returns.

Erosion in river valleys and plains is a much more serious matter, for on them depends the major part of the country's economy. In relation to these we can consider the part played by rivers, frost, sun, wind and rain, and the practicable measures that can be adopted to combat erosion.

From the agricultural standpoint erosion depletes the soil by removing the protecting top layer. It increases the destructiveness of floods, and by the deposition of silt and other erosion debris clogs reservoirs and other irrigation works, and seals the soil with fine suspended particles. It makes springs to dwindle, wells to fall, and rivers to degenerate, and destroys valuable property.

River Erosion.

The rivers cut canyons and gorges in the hills, mountains, and tablelands, from which they arise and carry the mud and sand washed into them by rain to the sea. Mud is essential, but the rivers, helped by rain, are draining it off the land. Their next activity is to wear down and pare away land from the banks, which means a double loss of soil and land. River floods, apart from causing loss of life and property and damage to or destruction of standing crops, deposit silt on the flooded areas. This deposition may be advantageous or otherwise according to its nature and the time it is deposited. The caking of the land after the water has dried up is injurious to the soil.

The wearing down and cutting off of banks by rivers can be minimized, if not actually prevented, by planting a fairly thick belt of soil-binding trees all along the banks. Actually only those spots could be reinforced where the force of the current is most felt, and this is usually at the bends in a river's course. But a full belt will also be helpful in checking to an appreciable extent the volume and force of the floods. Stone or concrete walling at suitable places will be impracticable owing to prohibitive cost. The earthworks, such as dykes and embankments, raised by the Chinese every year to check their river floods are not only ineffective, being washed away by the force of the torrent, but represent needless labour. Most of the soil-binding trees grow wild and require no attention; the laying of a belt will therefore involve only initial expenditure. The task will no doubt be stupendous. The gain will be the securing of a permanent protection, so far as it can go. Not the least benefit of such planting will be an augmentation in vegetation, the need of which will be further indicated. This will be the simplest, least expensive, and fairly effective method of controlling river erosion.

There is apparently only one way of adequately checking floods and that is to adopt a device offering the line of least resistance. Before it overflows the flood water should be diverted through suitable channels over as wide a channel network as would keep the river level normal. Since the canals will open again down the river the flood water can be drained off under regulated control. This water, while in the canals, could be put to a number of uses; in any case, it will be better there than flooding the land. The recurring expenditure on flood relief will be eliminated and, what is more, the needless suffering and crop failures avoided. The initial outlay on the canals, which can be only rough channels drying up when the water is drained away, will be more than repaid in a short period.

An alternative is to create a chain of artificial lakes and dams into which the water could be diverted. But having to be all along the river—it is not only melting snows but watershed area drainage in continuous heavy rain that raise floods—the lakes will have to be small, rendering water stagnant and establishing breeding grounds for mosquitos with consequent spread of malarial infection.

Frost Erosion.

What frost does to the rocks is not our concern; the damage it does to the soil is of a serious nature. Frost, or frozen dew, is just water that is precipitated from the atmosphere on to the land and soaks into it. With a low temperature it freezes first outside and then inside, and expands. This shatters the soil, resulting in the dispersal of plant nutrients, and because of this the crops cease to grow. Even if there were not crops the loosened soil is deprived of its contents.

Cover of the land is obviously the only remedy. Over uncultivated land it can be provided by growing grass; on crop-sown land this is manifestly undesirable since the grass will

absorb a good part of the nourishment of the crop.

The spreading of crop residues or stubble mulch over the uncovered parts after the plants have sprouted out can give the requisite cover. This cover will not interfere with the soil nor with its watering; will intercept the dew; prevent lowering of soil temperature and the soil surface from becoming caked by the evaporation of surface moisture.

The crop residues are at present used either as fodder or fuel, but this practice requires to be discontinued in the interests of soil conservation, particularly as there is no other suitable method of providing soil cover for cultivated land.

Sun Erosion.

A strong sun beating on the soil overheats it; the soil expands and its particles are detached. The soil loses in the same way as with frost.

Moreover, the imperfectly soaked water is exposed, becomes heated and evaporates. Thus of the total quantity of irrigation water only a part is retained by the soil, and its humidity suffers in consequence.

The same cover as against frost should be employed. In fact, this is the only possible cover in the case of sun and frost for cultivated land.

Wind Erosion.

The wind erodes by sweeping away the surface soil, or by driving sand and gravel against it. The effect of the latter is to loosen the soil by impact and cover it with a layer of sand, gravel, etc. Such covering chokes the soil, already with its nutrient particles dispersed, and renders it unfit for cultivation.

Growing grass on uncultivated and laying crop residues on cultivated land is only a half remedy in this case: the soil may be protected from loosening but the accumulation of sand and detritus still remains. This presents a difficult problem since, while the work of other agents is restricted, all land is continuously exposed to the action of wind.

Where sand accumulations are on a very wide scale, as in deserts, the region abutting on them can be screened only by a thick forest growth, which will impede sand in large quantities and gravel being pushed along to the land, though fine sand dust, which is raised to a height above the trees, will always find its way beyond the barrier. The desert has been invited to advance in the region from Delhi to Gwalior, because there is no check on drifting sand. Deserts do not advance by themselves, as such advance would mean that it is the inevitable trend of nature, like the falling of rain or the flowing of river. The flowing of sand over fertile tracts does not necessarily create a desert; the desert encroaches because desert conditions are created by man on its border. In this region there is no forest protection, and if this lack is allowed to continue the whole tract may be submerged in sand.

In this particular case, in addition to reforestation, which is essential and imperative and apart from the canalization suggested for flood control, it will be a further bar on the desert if the flood waters of the Ganga and Jumna, coming from the melting of snows and distinct from those of the watershed area drainage during the monsoon downpours, are trapped and diverted from the higher reaches of these rivers by suitable canals to the borders of the Rajputana desert. This overflow can then either lose itself into the sand or collect to form lakes. Water will be available, if it does not sink into the sand, for the growing of a forest. If otherwise, the moistened sand will reduce sand drifts; and there is the possibility of such sand, with patches of clay here and there, becoming spontaneously covered with a large growth of bush vegetation. The flood-escape canal net for these rivers will also be curtailed. The method is really pitting one destructive factor against another to neutralize both: the desert can absorb the flood and the flood can suppress the desert. These canals will have to pass above the latitude of Delhi, as further down the land gradient will not allow the water to reach the border.

Where there is no danger from accumulated sand and the wind merely works as a broom to sweep the surface soil, as happens on all level plains, intermittent tree screens alone can break the force of the wind. There should, in fact, be a ring of trees round every given acreage of land, a sort of a vegetative honeycomb, since long stretches of exposed land give the fullest scope for wind play.

This involves, in the aggregate, hundreds of thousands of acres of arable land being usurped by trees. But the choice lies between erosion and keeping the major part of the land free from its effect. Such trees could be fruit-bearing

ones which the cultivators coud look after, and which would be an asset to them as well as add to the food supply of the country.

Rain Erosion.

As rainfalls evenly in colder and temperate regions and long periods of drought and violent downpours are rare, erosion is almost negligible; but in warmer parts, like India, where rainfall violence is much more frequent, culminating sometimes in sheet-drop, erosion must necessarily be effected by rain on a devastating scale. The soil temperature being high, chemical break-down of vegetable and other organic matter is faster, and bacteria work at a rapid rate. Moreover, the periodic monsoon makes the rainfall over the year uneven. This poor distribution makes long dry periods in which the earth is baked and vegetation nearly desiccated, followed by a long drawn out period of stormy rain which sweeps away the soil. Spells of hot sunshine in-between heighten the rate of evaporation, with the result that the moisture is sucked up before it has had time to reach down to the sub-soil. This condition is more or less peculiar to India, which makes erosion through the agency of rain by far the most destructive.

The draining away of the surface soil is the final action of rain, and before this it causes extensive damage in many ways. The preparatory activity is the sorting out and collecting rich spoils from the land that have to be carried away. The impact of one rain drop on the soil is hardly appreciable, but when these drops are multiplied by the billions attention cannot but be arrested. They splash away whole layers of unprotected soil. Striking the wet earth the drops splash into the air small particles of soil, encased in a film of water, and thus cause erosion by displacement.

On level ground the splashing drops bound again and again in the vicinity, so that the displaced soil eventually remains in the field. On a slope, however, even though slight, the splashes move the soil downward, and this happens largely when the rain strikes glancing blows, the displaced soil gathering up at the slope bottom. This accumulation is further facilitated by the fact that a downward movement goes farther in the air than one upward and the displacement is therefore greater in the former.

Scour erosion caused by flowing water starts by grooving the soil to form gullies; splash, on the other hand, takes off the sloping surface soil in sheets. When scour erosion has sculptured large gullies the splash slopes their vertical walls, the soil from the top being piled at the bottom of the field. In its downward movement the soil slows as it reaches the gentler slope at the bottom; thereby leading to the formation of folds by the higher slope soil overtaking the material in slow motion. This is why crests of slopes, where there is little surface flow, are more damaged by rain splash.

The losses that are washed down the rivers are small compared to those by splash. About an inch of soil goes down the rivers from a whole watershed area every 300 to 400 years, and is only about 10 per cent of that from splash erosion. In heavy rain an average of 90 tons of soil per acre is blasted in the air: the more violent the rain the greater the damage by splash.

Splash by puddling the soil seals its surface, and makes it impervious to water and droughty. This, with a high temperature, destroys worm life and reduces productive capacity. The emergence of seedling plants from seed-beds becomes difficult, and aeration is also interfered with. Repeated surface sealing acts adversely on soil structure. When small soil aggregates on the surface are shattered by splash the pores in the soil take in water charged with colloidal and clay particles; this material is deposited and plugs the pores. As organic matter is decomposed in mineral soils small organically bound soil aggregates are formed. But when these are broken down by the force of the splash the loosened organic matter is floated away in continuous suspension. With the separation also of silt or clay particles, sand, and humus fragments of plant residues, the crops nutrients become deficient. Lack of adhesion makes the soil easily removable and transportable, and destroys its water-holding capacity.

The remedy is to minimize the impact of rain drops on the soil. Contouring and terracing, which check soil erosion, can save the splashed soil from being washed away, but they cannot protect against impact. Leafy plants bear the shock of impact and allow rain-water to trickle down to the ground. Groves of such plants, which should be fast growing, can provide umbrellas for crop fields. As violent rain mostly falls slantwise, because of the wind, a few trees can protect a large enough surface. Fields should therefore be spotted with trees suitably spaced. The spreading of crop residues will be a further protection.

The one fact that emerges from the foregoing study is that land should never be left without

cover : erosion always takes a foothold on bare land.

Soil Fatigue.

An overworked soil gets fatigued. This is different from exhaustion in which the soil is deprived of its productive constituents. To say that if the soil is renovated through artificial means by using fertilizers it should work as well as before, is to argue that, food producing energy, if a man eats as soon as he begins to feel tired he can go on working incessantly without requiring any rest. We know that it is not so. A replenished soil will no doubt function, but with diminishing efficiency, irrespective of the replenishment. For some reason it cannot function with its full capacity until it has had adequate rest. It is not known why this is so.

This fact is known to the cultivator by the experience of generations. He therefore gives cultivated fields a blank year or, at any rate, sows on them crops demanding lesser soil-activity. This method affords some relief, full recuperation being secured only when cropping is resorted to in rotation. To overwork land is therefore establishing a condition of erosion, the cumulative effect of which is to make the land go dead in course of time.

However, with the pressure on land, owing to increasing population, sufficient organic rest for the soil becomes very difficult to allow. Fortunately, however, there is in India plenty of uncultivated land which can be retrieved for utilization.

General observations.

Though several factors, such as geological formation, topography, climate, the nature of the soil, exercise their influence, vegetative cover remains the chief single controlling factor in erosion. Plants and trees break the force of the rainfall, and intercept a part of it. Vegetation allows increased moisture penetration and develops the water-holding capacity of soil by augmenting organic matter. It lessens sheet erosion by binding the soil; breaks the wind force; obstructs the run-off and, by lessening the velocity of flow, reduces the carrying power of water. It fills in small gullies; forms tiny terraces and dams on slopes; attracts moisture from the air; prevents rapid evaporation of water from the soil surface; tempers the sun's heat; and creates an equable temperature and a condition of humidity in which chemical reactions in the soil are facilitated. It therefore follows that cutting down of forests for timber and other wood products requires to be regulated in keeping with the maximum protection of the soil. With nearly half of the country possessing no vegetative cover actually more forests are needed in practically denuded areas. In Japan, a very small country, reforestation has been carried to the extent of 67 per cent of the islands' area being under trees. Our percentage is lamentably low. Research should determine the most suitable type of plant growth for the widely varying soil types and climatic conditions.

Over-grazing is the most important factor in reducing the protective cover on land. The plant roots are destroyed by excessive trampling, the sharp hoofs of cattle cutting into the soil. The soil becomes packed, and, as it cannot absorb water, gives no check on rain. Thin, nerve-like gullies are formed, speedily gain in depth, and accelerate the run-off. The soil deteriorates and curtails the productivity of grazing lands, eventually converting them into desert tracts. Ungrazed, well-vegetated land on slopes, even with a gradient of 90 per cent, has almost always a smooth, uneroded surface. The necessity of thinning out the live-stock to the extent the land can support becomes apparent. Cattle population, including goats and sheep, increases faster than human, and though its incidence of mortality is greater due to natural causes as well as man's food requirements, the number seems to be out of all proportion to the resources of the land. This, however, is as much an eroso-agricultural as an administrative problem.

Pasture-burning to produce succulent shoots is pernicious, as it causes severe soil loss by gullying. Crops should be so reaped as to leave all the residue in the fields. This is mostly used as fodder and fuel, but this practice requires to be discontinued.

All cultivable land should, like that on hill slopes, be terraced, strip-cropped, and contour-ridged in suitable units. Terracing was the only practicable method of growing rice, which has to be flooded in its early growth, by holding irrigation water. But it was also found to check erosion by preventing soil-wash. It is therefore only reasonable to terrace all other crop-fields, the rain water being slowly run off soon after the suspended soil particles have settled down. The saving in soil will be considerable, a little trouble paying beyond all expectations.

The alluvial soil of the Indo-Gangetic Plain is regarded as one of the best in the world,

responding easily to irrigation and manuring. But on the whole tropical soils are not so rich as they are believed to be. At any rate, they lack the capacity to retain their productivity to the extent of temperate region soils. The humus is rapidly used up, and the soil texture deteriorates with corresponding speed.

For 4000 years the Chinese have been cultivating their land without impairing its fertility. They have achieved this by giving to the soil, in the shape of a humus-rich compost, every scrap of organic matter saved from their homes. This astonishing economy deserves to be emulated.

At the outset it was suggested that other food resources, independent of the land, should be laid under contribution. One is river fishery, which can be raised to a major industry if only river pollution is stopped. Pollution kills fish. Sewage and industrial wastes by decreasing the oxygen content of water and increasing its acidity, alkalinity and salt content, by introducing poisonous substances into the water, by depositing a blanket of fibres and waste material on the bottom of the stream so as to destroy fish food, and by turbidity excluding light necessary for the growth of such food, make fish life, particularly fish spawn and fry, almost impossible, not only near the source of pollution but at relatively long distances. A major proportion of the number of fish that can thrive in a clean river is thus destroyed, depriving the country of the benefits of a food rich in iron, copper, iodine, and vitamins. The organic waste is readily decomposed but industrial wastes remain potent over long periods, and as they adhere to the river beds there is a continuous contamination of water, notwithstanding that fresh water is always coming from the source. As drinking water, river water is not so pure as it is supposed to be, and we are daily taking with it extremely minute quantities of a number of poisonous chemicals in very high dilution.

The municipal sewage could be filtered in large tanks and its manure contents removed before the water is discharged into the river, and in regard to industrial wastes, research laboratories should evolve methods of recovering profitable by-products, the remainder being run off into soak-pits.

STREAM TRAINING WORKS AT KALSANA ON THE MARKANDA RIVER

By Shri R. S. Chopra, Divisional Forest Officer, Karnal Division, Punjab

Introduction.

Markanda river is the biggest and most turbulent hill torrent in the North-West portion of the Karnal district, Punjab. It rises in catchment in the Nahan-Sirmaur hills of Himachel Pradesh, is fed in its downward course by a number of streams originating in the low hills of Ambala district and finally tails off in the Karnal district into the Bibipur *Jhil* from where an inundation canal has been taken out to utilize the accumulated water. Its course in the Karnal district stretches over a length of 18 to 20 miles and the bed width at places is over 2 furlongs. The torrent runs dry in winter, but in the rainy season it is visited by sudden, heavy and violent floods under which it goes on changing its course, deposits a lot of sand and silt and effects much damage through gullying and bank-cutting. To a certain extent the silt deposits are welcomed by the villagers as it improves their heavy clay so but the sand deposits and washing away of agricultural land through bank erosion are most troublesome. For some years past the course of the river has been deflected towards the right bank in its run below the Shahabad-Markanda railway station on the Eastern Punjab Railway. As a result, lot of agricultural land has been washed away along the right bank and sandy wastes in the form of discarded bed or otherwise are prominent at places along the left bank. Every year one village or the other suffered through the vagaries of the torrent. The Jhansa village fell a victim in 1944, Ramnagar in 1945 and Kalsana village, situated about 3 miles below the Shahabad-Markanda railway station was added to the list in 1946. Here a considerable portion of the village farm land has been washed away. The masonry columns of a few wells now sticking out in midstream bear eloquent testimoney to the havoc wrought. The current flowed right along the village, some houses were damaged and the entire village was threatened.

The ravages of Markanda attracted the serious notice of the Government in 1946. Remedial measures were discussed by the Karnal district

Civil and District Board authorities. In order to save the Kalsana and Jhansa villages the District Engineer suggested the construction of a 2 mile long earth *bund*, estimated to cost rupees 1,50,000, at each place. The proposal, however, did not materialize, as apart from financial difficulties in the construction and maintenance of the *bunds*, their utility was questioned in view of the everchanging course of the torrent. Finally the Deputy Commissioner, Karnal, was of the opinion that in the absence of a cheap and practical solution it would be simpler for these villages to shift their habitations wholly or partly to safer sites.

It was at this stage that the matter was referred by the Commissioner, Ambala division to the Forest Department. The Conservator of Forests, Fuel Circle, Punjab, inspected the Kalsana site in the summer of 1947, and opined that simple anti-erosion measures could be usefully employed in saving the village. The villagers were taken into confidence and they agreed to extend their co-operation in closing the marginal land and supplying free labour for the work. It was proposed to form a village Co-operative Society for the project but the Conservator of Forests, in view of the imminent danger to the village, ordered the Divisional Forest Officer, Karnal, to go ahead with the work pending registration of the Society. Then came the partition of the Province and the proposed Co-operative Society never came into being as the majority of the village inhabitants were muslims who evacuated. The Forest Department had to fall back on its own resources and has been carrying on the work ever since without help from any other source. The results achieved have been spectacular and are briefly recounted below:—

Works done and their results.

In the year 1947 a small beginning was made. Only six double line wooden spurs packed with brushwood were put up across the bank of the stream just above the village site. In-between the spurs some 4000 *Ipomea* cuttings and 10,000 tussocks of soil binding grasses, *e.g. kana*, (*Saccharum munja*), *nara* (*Arundodonax*), *kahi* (*Saccharum spontaneum*) and Elephant grass were planted to catch the silt and stabilize the soil. On the stable bank behind the spurs 1,500 *shisham* (*Dalbergia sissoo*) plants were put out. Unfortunately in the 1948 floods the course of the river was further deflected towards the right bank about half a mile above the Kalsana village. In consequence all the spurs were washed away, but the planting persisted here and there and resulted in casual deposits of silt. In winter, 1948 the situation was studied more thoroughly and in the light of experience gained the works were planned over a wider field. Nineteen double-line wooden spurs were made covering a section of the bank from about half a mile above to well below the village site. In-between and behind the spurs close planting of *kahi*, *kana*, *nara*, elephant grass, *Ipomea* and *vana* (*Vitex*) was done, totalling 35,400 running feet. Small gullies were plugged and formation of back water pools guarded against. *Shisham* planting was repeated on firm ground behind the spurs. The works withstood the 1949 floods well and proved highly useful in drifting the current away from the village. Silt was deposited all along the treated bank, about 3 to 8 feet deep in places. The *shisham* and miscellaneous planting showed good development. In the winter of 1949 all the spurs were repaired and 9 new spurs were constructed between the old ones at places where the current was strong or where deep pools of water were formed. About 9,000 tussocks of *kahi* and *kana* grasses, 500 *shisham* stumps and 60,000 *Ipomea* cuttings were planted. A thick belt of *Ipomea* cuttings (1×1 spacing) was planted in front of the spurs in the stream bed to act as additional silt-traps. These attained a height 2 to 3 feet or more by the beginning of the 1950 rainy season.

The work was inspected at the end of July, 1950 after the heavy floods resulting from a downpour stretching over a fortnight. The results were all that could be desired. The spurs and planting had done their job well. There were substantial silt deposits all along the section. The *shisham* plantation at the back showed good development and the *Ipomea* and grasses planted had grown up thickly in the portion protected by the spurs. The *Ipomea* vanguard had perished but not without earning a V.C. for the valiant resistance it offered to the current. It lay sacrificed in trapping silt to such an extent that over its buried remains a regular formation of high bank is noticeable in front of the spurs.

The end result of three years of effort has been that the force of the current near Kalsana village has been broken and diverted, averting immediate danger to the village. Only small pockets remain to be liquidated at the tail end so as to ensure better safety. It might take a couple of years more to complete the job. A strip of land varying in width up to 100 yards has been reclaimed along the treated bank above the village and its consolidation through planting is well on its way. The ultimate

success will depend on how far the villagers respect this protective work which, apart from its local value, furnishes a good example of a simple and effective method of repairing the damage done by hill torrents in the locality.

It is possible to recover more land locally by gradually expanding the sphere of activities, but the larger interests will be best served by a systematic treatment of the upper catchment area of the torrent in order to reduce the intensity of the floods and the carriage of silt, and by establishing protective tree belts along its banks in the lower reaches so as to confine the current to a defined bed as far as possible.

Costs.

The picture will not be complete without mention of cost of the operation. The total expenditure incurred on the works carried out during the 3 years from 1947-48 to 1949-50 amounted to Rs. 6,500/-. More than half of it represents the cost of sal (*Shorea robusta*) *ballies* required for making the spurs and their carriage to site. The expenditure, though very small as compared with the engineering *bunds* contemplated in the beginning, is not a dead loss. It is rather a long term investment. The money spent will be amply repaid by the *shisham* plantation alone when it matures in time, leaving aside the value of the land recovered from the river action.

ECONOMIC INFLUENCES ON SOIL USE

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Apart from the topography of the land, its subjugation to the natural forces of wind and water under the extreme conditions of complete exposure, the negligence and ignorance of the cultivator in adhering to destructive type of primitive cultural practices and in tearing his land into inconvenient number of pieces and his greediness to extract the maximum return with little out-lay, there are factors beyond the purview of the cultivator yet profoundly affecting his treatment of the land. They are the overwhelming economic maladjustments and disturbances such as instability of production, prices and income, the recurring cycle of business boom and depression, the relations between industrial and agricultural production and prices, the dislocation of trade due to war, famine and pestilences, these are some of the indirect influences on soil-use, for good or ill, less easy to trace but overwhelmingly important.

The wide fluctuations in agricultural prices and income during the last decades have been responsible for the opening up of the land to speculative farming without sufficient regard for the maintenance of fertility. The instability in crop acreages is attributable to adjustments of crops and livestock by the farmers to changing prices. The paddy-growing farmers have in recent years converted their fields for sugarcane production with the increase in demand for sugar and jaggery. Cotton and tobacco have also displaced rice when tempting prices were offered by the mills. These shifts in the aggregate of individual crops are as great and pronounced as changes in non-agricultural industries.

A perusal of the crop returns reveal what the weather has done to agriculture. There have been recurring crop failures in non-irrigated arid regions due to insufficient or untimely rainfall. Similarly in the humid regions floods due to stormy rains have tended to pull down the average level of yields. Apart from the instability in yields per harvested acre, there is the wasted effort and investment involved in planting acres that are not harvested due to the adverse weather conditions. Cases of total crop failures on the verge of yielding are not uncommon.

The volume of crop production in any particular year exerts a disturbing influence on the money returns of subsequent crops. This is particularly true of cash-crops. The domestic as well as foreign consumption of these commodities, varies relatively little compared with the wide variation in production. Bumper cotton or tobacco crops, for example, result in surplus of stocks and thereby tend to depress prices for two or three years until the excess stocks are brought down to normal.

Even if the farmers endeavour to curtail production after a bumper crop, the additional carry over may be so large as to more than offset the amount of reduction. As it is unlikely that there will be a rise in the prices corresponding to the reduction in the crop, the farm income is proportionately affected.

The upsurge in exports in the recent war period has been the cause of exploitative cultural practices and abuses of land resulting in depleted soil fertility. The swing towards cotton and tobacco, intensive cultivation of wheat and rice crops to feed the soldiers abroad, are significant features of war-time agriculture. During the depression of pre-war years there was a heavy slump in the demand for the agricultural products in the domestic as well as in the foreign market. The instability in the industrial activity had an adverse effect upon the consumer's purchasing power thus leading to greater instability in farm income. The land values have declined sharply and due to relatively high debt and tax charges and falling foreign and domestic demand under the heavy competition of imports there was a grave disparity in the per-capita income of the rural and urban areas. Due to the heavy demand for farm products during the war and also in post-war years owing to the food-shortages and lack of imports, there is a boom in the farm income and the disparity between urban and rural incomes have been to a certain extent dispelled. There was a heavy similar demand for livestock production during the war period. This general rise in farm income is obviously due to the upsurge in the consumer's purchasing power with the expanded industrial activity.

In addition to the instability of weather, foreign demand, and general business conditions, there is also the instability of monetary and credit conditions which bring about great variations in general level of commodity prices. This type of instability, particularly war inflation, is perhaps the worst that any generation of farmers can be afflicted with, for it not only distorts price relationships and the judgment of the farmers as to what they should do with their land and their incomes, but serves through its consequent deflation to undermine agricultural welfare for many years.

The instability in farm product prices would have somewhat less drastic effects on farmers if prices of industrial products showed similar flexibility. While industrial prices have been affected by war-time inflations, as were agricultural prices, their short-time fluctuations are not as marked. As a result farmers and tenants who speculated banking on war-time inflated earnings, as prices tumbled and took land values down with them, were left with mortgages that could not be met with reduced earnings. In many ways the inadequate income during the post-war deflation period tends to affect soil use. For example, the increase in farm tenancy which accompanied the rise in prices and land values meant an increase in systems of farming that exhaust soil resources. The pressure of debt and taxes when deflation sets in prevents many farmers from utilising adequate crop-rotation systems, fertilizers and other soil and fertility-conserving practices.

The general trend of the economic instability has in recent years been important among the influences tending to place agriculture in a position such that investments necessary to maintain soil resources at their optimum cannot ordinarily be met out of farm income. The pre-war drive for self-sufficiency created at a pressure to contract resources devoted to agriculture. In countries like U.S.A. stabilisation by means of legislation was brought into force. But the war itself created a profound distortion of the world economy. Due to the shifting of labour to battle grounds and war industries and the colossal waste of food stuffs with the dislocated communications and the rapidly changing fronts, there was a terrible shock to the agricultural economy of countries which lagged behind in production techniques and relied upon imports. Scarcity, famine and mal-nutrition are the legacies of the pre-war negligence in accelerating production to the optimum level. The development of centralised economic controls during the war in conjunction with the disastrous experience of starvation gave impetus to the idea of national planning but whether it leads to recovery and self-sufficiency or to collapse depends largely upon the methods of evolution and energy of execution of these plans. The aim should be increased production on modern lines with soil conservation and good farm management on widely expanded and reclaimed areas. During the period of adjustment, it will probably be necessary to subsidize the farmer by conditional grants of money in order to secure full maintenance of soil resources.

A sub-continent of the extent of India with its growing population groaning under recurring famines and mal-nutrition cannot afford to rely upon imports of food-stuffs at exhorbitant prices at all times. The consequence of a policy of rapid industrial expansion with mere tinkering of agricultural development

leads to a further unbalance of the industrial and farm incomes and estrangement of urban and rural areas. The results of wide disparity between agricultural and industrial production will be the betterment of the lot of the industrial worker at the expense of the farmer. Hence it is essential that agriculture should be geared to industry especially in an agricultural country like India. No doubt the unbalance between agriculture and industry arises primarily from the difference in the organization of these two fields of activity and the effect of the difference in prices and production policy. Whereas the bulk of the agriculture is carried on by individual farmers with a few hired workers, the bulk of the industry is carried on by big corporations and cartels. The result of the economic concentration in industry is the dominance of the market by the highly organized corporations to the detriment of the millions of separate farmers who compete with one another in supplying farm products. Thereby they hold little control over the prices while the corporate concentration in industry leads to inflexible prices by means of controlled production. But the latter is a necessary evil, concentration, production control and inflexible prices are inherent in the organization and techniques of modern industry, for keeping the advantages of mass production. The obvious remedy is to accelerate agricnlural production on well-organized and advanced lines and create favourable conditions of market by eliminating unfair competition. Under the existing conditions, the agriculturist is left to be a victim of his environment over which he has little control, and it is not to be expected that the farmer can do a better job of managing his soil resources on scientific lines that he has done in the past unless the uncertainties and fluctuations in prices and demand are minimised and income from farming is placed on a more stable basis even by means of state aid, if necessary.

GROW MORE TREE CAMPAIGN*

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We are fairly familiar with compaigns "Anti-illiteracy", "Anti-locusts", "Prohibition", "Anti Corruption", "Grow More Food" and the like. We have recently heard of "Grow More Tree Campaign". It is better started late than never. That the campaign is being sponsored and patronized by such eminent personages as our Governor General, Prime Minister, Provincial Governors, Premiers, and Ministers, gives us an idea how vitally the problem of growing more trees concerns the nation.

That trees have been indispensable friends of humanity all through is beyond doubt. Tree cultivation and preservation have been the great concern of the human beings—which was evinced in orthodox religious worship of shade trees like *pipal* and *ber* and of tree groves, etc. Tree planting was then considered a benevolent act. This was the unsophisticated pastoral form of appreciation of the "tree" which yielded us fruit, shade for rest, fodder for cattle, hedges for fields, fuel for the hearth and timber for the house. With the advance of civilization blind worship rationalised itself into a more realistic appreciation of the blessings of 'trees', when large scale avenue planting programme along canal banks, District Board and P.W.D. roads, raising of extensive fuel and timber plantations, and afforestation of denuded areas was embarked upon by the State.

On trees and for that reason on the forest resources of a country largely depends the nomic stability and prosperity of a nation. To the Forests we look for our innumerable daily requirements. The forests feed a large number of small as well as large scale industries such as charcoal making, saw-mills, rosin and turpentine manufacture, midicinal oil extraction, basket making, paper making, match making, boats and ship building, sports-goods manufacture, furniture making and rope and fibre making, tanning and so on. One can very well imagine the enormous contribution that forest wealth can make towards the prosperity of a country. If the resources are properly exploited, forest

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industries can absorb a large number of the country's nationals to help solve the problem of unemployment. It has been estimated that if at least 25 % area of a country is under forests, then alone it can ensure self-sufficiency in its requirements of fuel and timber. In India the proportion is well below this sufficiency limit. The post-war forest policy of India envisages considerable increase in forest areas. It is contemplated to bring a large extent of village wasteland under tree crop by raising plantation, by encouraging village community to grow sufficient trees in their village wastelands to ensure them self-sufficiency in the supplies of timber and firewood—thereby to save cowdung for manure. The plan is very ambitious, and we hope good sense will dawn upon us sooner than later and we shall realise the necessity of growing more trees—timber, firewood and fodder trees.

The forests constitute the potential wealth of a nation and on these depend both its health and prosperity. These are the reservoirs of water supply which feed wells, springs and canals for irrigation. On forests depend the rainfall and climate. The blessings of forests can probably never be overestimated.

We have enumerated enough of the benefit that accrue to a nation from its forest resources. Let us pause and ponder, as to what extent we are actually contributing to increase our forest wealth. No one dare refute that forest areas are being destroyed and exploited at far greater rate than they are being afforested and regenerated—artificially or naturally. The population of our country is increasing at an appalling rate as also its requirements of forest produce. The lust for money has given us great temptation to destroy our forests to sell off timber, firewood, charcoal, regardless of the requirements of posterity. This state of affairs is manifest in the terrific rate at which deforestation going on all around us, resulting in denudation and soil erosion, loss of soil fertility, devastating floods, destruction of agricultural fields and lowering of the water table, which follow in the wake of injudicious deforestation.

We require a fundamental change in our outlook towards tree wealth. Our vision has been clouded by our instinct for money making only. We are depleting our tree wealth without replenishing it. A very sane advice is to look at our forests as the wealth of the nation ; a share equal to the interest thereon (we call it 'increment' in forestry) may only be exploited year to year. Only as much of gaps should be created as we can naturally or artificially refill. The old man who was seen planting a mango tree (to bear fruit for his grand children) was saner and nobler in his sentiments than most of us are. We all need follow his noble example.

Much has been said in forest Working Plans and Government reports about India's rapidly depleting forest wealth, and prejudicial consequences it was to have on India's economy. A lot has been said about the ways and means of replenishing it. It is incumbent on every national of our free country to wake up to the grave dangers that lie ahead of our selfish negligent and indifferent attitude towards our tree wealth. Hitherto it has been the exclusive concern of the Forest Department to plant trees. What is now actually desired is that each member of the village community should undertake to do his bit. To accomplish it, all public servants—village school masters, postmasters, panchayat members, lambardars, M.L.As., patwaris, co-operative bodies and all should organise tree planting drives with the guidance and assistance of Forest Department to make the masses forest minded. The villagers should be persuaded to grow more fruit and fodder trees around the village paths, ponds, public buildings, around their fields, in their waste lands, etc. and co-operate with the activities of the Forest Department in raising large firewood and timber plantations, canal and roadside planting, afforestation of waste lands and contribute to the forest wealth of the country. Let us one and all solemnly pledge ourselves to the slogan "Plant 10 trees for every one felled," and carry this pledge to every nook and corner of our country.

A few verses by Henry Abhey on "when we plant a tree" are interesting. I have taken these from the Indian Forest Rangers College Annual, 1942.

"What do we plant when we plant a tree ?
We plant the ship which will cross the sea ;
We plant the mast which will carry the sails ;
We plant the plank to withstand the gales,
The keel, keelson, the beam, the three,
We plant the ship when we plant a tree.

"What do we plant when we plant the tree ?
We plant the houses for you and me ;
We plant the rafters, the shingles, the floors,
We plant the studding, the butts, the doors ;
The beams, the siding, all parts that be,
We plant the house when we plant the tree.

"What do we plant when we plant the tree ?
A thousand things, that we daily see,
We plant the spire that at towers the crag,
We plant the shade from the hot sun free,
We plant all those when we plant the tree."

SUGGESTIONS FOR THE CONTROL OF DEFOLIATORS IN HIMALAYAN FORESTS

BY M. J. KIRCHNER, SIMLA

How to Confine Outbreaks.

The life-cycle of the *Ectropis deodra* is well-known. The pest lives either underground, as pupa, or on top of tall trees in the shapes of winged male, egg-laying female, and caterpillars of small and mature sizes. All places where we cannot control the outbreak. The one chance is that we prevent the wingless female moth from crawling up into the canopy —that is from laying any eggs at all. Our battle-ground is thus the lower end of the trunk, say ten feet up from the ground.

This is no new aspect of the problem. The practice of banding trees with tar, or other sticky substances, originates from the same idea. The practice of banding implies usually the use of coal-tar, preferably brought hot to the worker on the spot. This is one of the snags. The consumption per tree may amount to about one lb. of tar, and we are thus again confronted with a very difficult transport problem, to say nothing of the labour and other costs. Banding takes considerable time, and it happens in dry weather that the rings of tar have dried up before the other end of the area has been treated. Or the bands get covered by deodar needles and dust, and the moths have a walk over. In other words, banding is slow, clumsy, expensive, and often ineffective.

Dusting instead of Banding.

The obvious alternative is dusting the trunks, six to ten feet up from the ground, at the scene of outbreaks, as soon as the female moths appear in March/April. This introduces the factor of timing, which is less important with treatment from the air. Reports of crawling female moths necessitate immediate action. Not a day may be lost. There is no time for ordering insecticides and equipment in such an emergency. All preparations have to be made beforehand. Confining an outbreak of *Ectropes deodara* is rush-work, just as putting out a bush-fire. In some cases hundreds of acres will have to be treated within one week. And all this must be done in wintry weather, at high altitude, in places of bad accessibility. (See Figs. 1 and 2).

Calling the Mobile Squad.

It has been stated that outbreaks of defoliators may be very serious but that they happen at great intervals and that Indian States cannot afford to make costly preparations for compaigns which may not be necessary for a number of years to come. For this reason, and because of justified doubts in the efficacy of handling, small outbreaks here and there are allowed to get out of control. There is, after all, no effective way of confining such outbreaks hitherto, and it may be hoped that they would not get too bad. This practice may provide all the makings for a really bad infestation, which may become something of a national disaster.

The solution, which I suggest herewith, is, therefore, the setting-up of a Central Mobile Squad for the control of defoliator outbreaks on any spot from Kashmir to Assam, which Squad is to be stationed at the FRI, Dehra Dun, and to be kept by the Centre.

Before I go into the details of running such a Squad and the equipment which will be needed, I may emphasize that the work of the Mobile Squad will come to nothing, if there is not an efficient warning system by which outbreaks of Ectropis defoliators are notified—by telegram—to the FRI, at the stage of crawling females. Messages which report the appearance of caterpillars mean simply that the crucial stage of crawling female moths has been overlooked. This may not happen.

Crew and Equipment.

The crew of the M. Squad may be composed of two Assistant Forest Entomologists and six volunteers (students of the FRI, Dehra Dun), one driver and one cook. The Squad should have one lorry, of the military type, four-wheel-drive, $2\frac{1}{2}$ tons. The equipment should be packed *and loaded*, ready for immediate departure at a few hours notice. Provisions should be made for warm clothing (battle dresses, military boots, blankets, gloves), sleeping bags, iron rations for two weeks, cooking-kit, tentage, and first-aid-kit.

The dusting equipment may consist of hand bellow dusters (such as shown in the pictures) or Rotary and Knapsack Dusters, which will have a much higher efficiency. One dozen dusters may suffice. One ton of insecticides repacked in handy 56 lbs bags should be ready in the lorry, which can be transferred to porters or mules, whenever necessary.

Fig. 1

Dusting of Deodars against crawling females of *Ectropis deodara*.
Dusting low. Hand Bellow Duster, @ Rs. 40/0.

Fig. 2

Dusting technique against crawling moths.
Dusting high. Hand Bellow Duster, @ Rs. 40/0.

Action on the Spot.

The Squad is to be met at the head of the motorable road, or at the destination, by the staff of the State Forest Department. At the scene of the outbreak each volunteer will form a group, with three local men. Two are to handle one duster each, the third man will carry refills and food. One hand bellow duster will do 100 trees per hour, at a consumption of four lbs of dust, dusting from 8 to 10 ft. length of the trunk, as the illustrations indicate. Knapsack dusters may do considerably better, at less consumption of insecticide dust. A group will thus treat about 1600 trees per working day. Six groups could thus do almost 10000 trees per day, at the total consumption of 400 lbs. of dust. The ton of dust would suffice for about 55000 trees. The lorry would always be able to rush up a second load within a few days. The dusting technique is so very simple that any labourer is able to do the work after two minutes instruction.

Choosing the Insecticide Dust.

In many countries the geometrid moths have proved to be highly susceptible for insecticides. I suggest that the DDT and BHC compounds for agricultural pest control be given a trial both. Judging from past experience, it may be expected that DDT, with its long residual effect, will turn out to be the most economical product, when the figures of economy will have been worked out in the practice. The problem is one of having sufficient insecticidal effect for several weeks, so that late-comers may also be prevented from going up the trees and laying eggs there. One treatment only can be given anywhere. Modern insecticides can stand rain and wind and sunshine and yet remain effective for several weeks.

Entomologist will obtain satisfactory mortality figures of moths by using 5% dusts in the beginning. Their problem will not so much be to establish whether the moths can be killed at all, but the economy of the campaign. Will a 3% Dust have the same effect as a 5% Dust ? The initial stocks may safely be chosen from 5% concentrations, with a few bags of 3% stuff thrown in, for trying the cheaper way, too. The cost of the insecticide will range from Rs. 800/0 to Rs. 1400/0 per ton. The dusters may cost from Rs. 40/0 to Rs. 150/0 each. The lorry may be borrowed, just as tentage, and wearing apparel.

The Mobile Squad at Dehra Dun need not cost much. The total expenditure will be only a fraction of what an airplane, or helicopter would cost.

AN ENCOUNTER WITH A TIGER.

By D. D. Chopra,

Deputy Conservator of Forests, Uttar Pradesh.

One afternoon in November 1928, when I was cycling along a narrow forest road from Gola Tappar to Kamsrao in the Dehra Dun forests I met with this unique accident of my life. The road had been just cleared of grass after the rains and there was tall grass 8-10 ft. in the forest along both sides in that big prairie called Chandi Tappar which lies between the Jakhan and Song rivers. The place was quite lonely and deserted as the *gujars* (hill tribe) had not yet come down from the hills.

I had just bought a new 'Raleigh' push-bike on which I was riding and it was quite noiseless. When I was about a quarter of a mile from the Jakhan river in the midst of that high grass-land, a full-grown tiger suddenly emerged into the road from the grass and I very nearly ran into it. I was cycling pretty fast, say at not less than 12 miles per hour, when I ran into the tiger which probably wanted to cross the road; my forewheel either hit his body or was just about to hit it when I managed to stop, the bike by applying both brakes and got down. I remember that after getting down I stood motionless without losing my presence of mind. The tiger at once gave a big growl and stood erect on his hind feet, right in front of me with great fury and that not more than six feet away from me; this I fully remember. Since I did not cry out or make any other noise or try to run away he probably got frightened (as these animals are normally afraid of human beings) and

after a couple of seconds he turned back, took two big leaps away from me in the direction I was going and started running away. After going distance of about 40 ft. he again turned towards me in great anger and again stood erect on his hind feet. But finding me standing still in my place, he gave another big rowl, leaped back into the high grass and disappeared.

All this took hardly a few seconds, and I was left stunned, when he had disappeared from my sight; I then came back to my senses and realised the seriousness of the situation I had been in. I was almost trembling and was feeling as if the earth below my heels was shifting away. I soon tried to pick up my courage and control myself. I had to go in the same direction the tiger had proceeded and was afraid that he might be hiding in the tall grass close to the road and jump on me the moment I passed by him. I started ringing the bicycle bell and rode on though trembling with fear. I was not in my normal breath till I was at least a furlong away from that spot.

I started thanking the Almighty for saving my life so miraculously.

The tiger might have finished me off with one blow. I had no weapon with me and even if I had one it could not have been of much use in such circumstances. I had not insured my life adequately heavily at that time and the first thing I did on reaching my home therefore was to apply for another life policy. My friends have been quite interested to hear this story. In 1938 when I was arranging beats in a bird shoot in the famous Chandnawarao for His Excellency Lord Linlithgow, Sir Gerald Trevor, Inspector General of Forests, related this accident to Lord Linlithgow who sent for me and asked me to relate the whole incident.

The Viceroy who had shot a large number of birds that day was in good mood; he heard my story and of the providential escape with much interest.

CONTOUR TRENCHES AND THEIR ROLE IN SOIL CONSERVATION AND AFFORESTATION.*

BY V.S. MADAN, D.F.O., HOSHIARPUR DIVISION.

I. INTRODUCTION.

Contour trenching is one of the several forms of contouring and implies a system of ditches and ridges systematically aligned along the contours. The ultimate object of contouring is :

(i) to reduce soil erosion in areas of high rainfall,

(ii) to conserve all available moisture in areas of deficient rainfall.

Contouring ensures this by breaking the velocity of the run off, the dispersal of water uniformly over a wider area, and the retention thereof in several sections of the catchment surface. Some of the well known forms of contouring practised in this country are :—

(i) The Bijapur type bund of shallow burrow-pits and ridges.

(ii) the shallow trench and ridge.

(iii) the deep trench and a ridge (Jaijon type).

(iv) the American broad based terrace, and

(v) the *Wattbandi* with a contour bund.

II. SOIL CONSERVATION—ROLE OF CONTOUR TRENCHES.

The problem of soil erosion from the denuded hill sides and the ill-designed cultivated fields along the slopes and foot-hills is being very widely appreciated. The phenomenon of rainfall directly impacting the soil surface devoid of any vegetative, protective and stabilising cover, dislodging the soil particles, and carrying in solution and suspension tons of valuable top soil in its sweep is too well known to be elaborated. The removal of soil layers from a sloping surface, uniformally over an area in the form of sheets, is popularly known as "Sheet Erosion". This sheet erosion is responsible for the removal of 50 to 200 tons of valuable soil per acre per annum, depending on the slope, degree and intensity of rainfall and the soil texture. Effect of sheet erosion may be pronounced in areas where the mineral sub-soil gets exposed, but where the surface is better protected with vegetation, the loss may be inconspicuous and imperceptible for a long time. The object of contouring is to conserve the soil and protect it against this wash by reducing the run-off both in its velocity and magnitude. This can be achieved by the restoration of the vegetative cover which would intercept the impact of the rain, retard the velocity of the run-off and help absorption and retention of moisture in the ground by a network of numerous root systems which make the soil more porous and absorptive. Contour trenches have adequately achieved these objects.

III. FUNCTION OF CONTOUR TRENCHES.

The function of contour trenches carefully aligned along the contours is to divide the entire catchment area into a series of small catchments, thereby reducing the extent and velocity of the run-off and the soil loss. The soil wash and the water from the interspaces are held by the contour trenches, ensuring the absorption of the water into the ground, increasing the moisture content and thereby its productive capacity. This results in increased yield of every type of crop, commercial plantations, grasses or cereals. Several instances can be quoted to show that sowings in sites wherein such water catching devices as contour trenches and contour bunds have been employed, have been far more vigorous than those on untrenched slopes. In the Pabbi hills of Gujrat district 40-70 years old sowings of *Prosopis* on unbunded land have put on very little increment, as compared with 20 year old sowings of even more exacting species like *shisham* and *siris* which have produced trees of over 10″ diameter in the neighbourhood of the earth bunds behind which the greater part of rainfall had been stored. Trenches on poor sandy soil under a thin canopy of *chil* in Sidhchalehr in Hoshiarpur have yielded as much as 50 maunds per acre of *bhabar* in the fourth year of planting against 10-15 maunds in second and subsequent years of planting on untrenched slopes. Some of the three-year old plants from sowings of *kikar* along trenches in Sidhchalehr Shamilat measure 11-12 ft. high. This rate of growth could not be expected from ordinary patch sowings on an untrenched area. Same accelerated growth has been obtained in Maili Bachoi, Jaijon, Chohal and other localities in Hoshiarpur

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division and elsewhere. Results of sowings on the berms of trenches have been so encouraging that in Hoshiarpur, *kekar, khair, phulai* sowings in hills are now entirely restricted to trenches. Patch sowings have been entirely discarded.

IV. CONTOUR TRENCHES AND NATURAL RECRUITMENT OF GRASS.

In Polian-Jaijon trenched area of Hoshiarpur, natural recruitment of grasses in the trenched areas is high thereby showing that even if propagation of tree species cannot be attempted because of the initial low fertility of the soil in the beginning, the natural recruitment of grasses as a result of trenching would alone justify trenching. This would, in due course, help to build up the soil and lead to natural succession of the more exacting broad leaved species like *khair, siris, shisham* and *semul*, etc.

At the commencement of the vigorous trenching campaign in village forests in Hoshiarpur on an extensive scale a few years ago difficulty was experienced in securing public co-operation on account of the erroneous apprehension that the trenching would result in decrease of the area of the pasture land with a consequent decrease in grass yield. It is, however, gratifying to note that the villagers are now realising the utility of trenching and finding that it actually means increased grass yield every year after about the second year of trenching. In Bharwain Range people from some of the villages have approached the Forest Department for favour of getting trenches dug in their wasteland in the interest of more and better grass. A few years ago it would have been a favour on the part of the villagers if they had permitted their area to be trenched.

V. LAY OUT

The efficacy of the contour trenches mainly depends upon the accuracy of their alignment along the contour. Improperly constructed ditches and ridges may increase erosion, as a series of short interrupted trenches divert water on the edges of gullies already actively cutting into the soil. Incorrectly designed trenches are more susceptible to breaches, and get silted up sooner and require more repairs, and defeat the very fundamental object of contouring. Contour trenches are not straight lines but must be laid out accurately level so as to catch the maximum quantity of water. In the matter of choice between short lengths of interrupted trenches and continuous and fully contoured ridges there can be no doubt about the higher efficiency of the latter and as far as possible a continuous line accurately contoured should always be aimed at except where the ground is so steep and stony as to render it impracticable. On gentle slopes unobstructed by tree-growth shallow burrow pits are cheaper but on steeper slopes carrying scrub forests, trench and ridge type contouring is more effective. In practice contours are laid with the help of:—

(i) a wooden frame 4″ wide, 3/4″ planking cut into a triangle, with a base of 12′, fitted with a masons spirit level in the cross bar half way between the base and the tip of the triangle, or

(ii) a horizontal wooden frame 2′ high with 2 slanting legs 12′ apart at base and horizontal plane being 10′ long and 4″×2″ in section marked in the middle where spirit level is set and bubble centred for each section of the contour. (There are more elaborate instruments also for laying out contours, like Abney's level and other levels like Dumpy, Cushing, Ziess, Roorkee Pattern, etc., etc., *but are not so handy and require* more skill in their use).

In the case of the above mentioned wooden contour trenching frames, pegs are fixed at either end after the bubble is centred and keeping one end fixed the other is swung in the direction in which the contour to be laid. At this point another peg is fixed when the bubble is centred. This is continued along the workable length. Position of the pegs gives the line of contour, along which trenches generally 10′×10′×1′ are dug. According to the general prevailing practice the distance between the trenches along the contour is kept at 2′ and horizontal distance between the contour at 10′. Trenches may be deeper (if ground is not hard) and closer in case of steeper slopes and in case of gentle slopes these may be spaced at 15′ horizontal distance.

If the surface is badly broken and obstructed by bushes or other rank growth or is hard and stony, trenches may be smaller in size and their depths may also vary (their variations are, however, only necessitated by soil and topographical conditions) according to soil conditions. Whatever their length, the berms and the ridges constitute the planting sites.

The main points which deserve special attention in the construction are:—

(i) The hillside edge of the trench should be dressed to a slight gentle slope, to avoid vertical bank, which keeps on falling.

(ii) The edge of the trenches should be angular and not circular.

(iii) The dug up earth should be heaped into a ridge leaving a clear distance of 3"-6" from the lower edge known as berm. This berm is the most suitable place for sowing after it is properly worked up with a *khuttie*.

(iv) The ridge should be properly consolidated and its tip flattened to about 6"-9" width and its lower surface dressed and rammed to a gentle slope by means of the back side of the spade.

(v) The bed of each trench should be strictly level and the section of the trench should be uniform throughout. This should be tested by a testing wooden plank and a spirit level and the berms of all trenches should be strictly along the contour.

(vi) The ridges should be continuous, along the contour, even though the trenches are interrupted by 2' interval along the contour. The trenches serve as the reservoir of water and retard the soil wash, whereas the ridges serve as contour bunds and add to the utility of the trench in controlling the run off and dispersing the overflow uniformally along the contour.

(vii) Horizontal spacing between the contour lines should vary from 7' to 15' depending on the slope. The steeper the slope the closer should the lines of trenches be. In no case should a slope steeper than 20% (1 in 5) be trenched.

VI. FINANCIAL ASPECT—COST ETC.

Reckoning 200 contour trenches 10'×1'×1' per acre on a gently sloping area spaced 15' horizontally between the contours, the cost of trenching per acre would vary from Rs. 25/- to Rs. 32/- at present depending upon the type of soil. This would include contour ridging along the lower side as well. The cost will be higher on sticky clay and stony soils than on loamy soils.

The cost of sowing such trenches with species like *kikar*, *khair*, *Prosopis* would be roughly Rs. 4/- per acre, and that of subsequent weeding, replacement of failures and tending for the ensuing 5 years, Rs. 5/- per acre. So in an average quality area, an acre of afforestation trenches including sowings, etc., will cost Rs.36/- to Rs. 43/- per acre after allowing Rs. 2/- per acre for repairs to trenches.

Planting of *bhabbar* on these trenches @ 20 tussock per trench would cost Rs. 15/- per acre. Stocking the area with *bhabbar* will cost Rs. 40/- to 47/- per acre and adding Rs. 5/- per acre for weeding and replacement of failures it would work to Rs. 45/- to Rs. 52/- per acre. An acre of well stocked trenches may yield 15 maunds *bhabbar* in the second year, 25 maunds in the third year and 45-50 maunds in fourth year and for some subsequent years.

SAMPLING TECHNIQUES FOR ESTIMATING TREE GROWTH AND VOLUME BY SELECTION OF SAMPLE TREES FOR MEASUREMENT WITHIN INDIVIDUAL SAMPLE PLOTS.

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SUMMARY

On the evidence of the results obtained from the data of 5 clearfelled sample plots of different ages, species and localities, the following conclusions may be drawn :

1. The present method of selection of sample trees for measurement in a sample plot, is a biased method which always gives higher figures than the actual values as well as those derived by random sampling both with and without stratification.

2. The current method (based on Schwappach's height and form factor curve method) may be replaced by stratified random sampling scheme which has given more satisfactory results than the former.

3. To estimate tree growth and volume of a sample plot by stratified random sampling design, with sufficient precision for all practical purposes, a sample should consist of at least 15 trees.

Sample plot method is one of the main techniques followed in India for estimating tree growth, volume, yield etc. The objects of a sample plot, as laid down in Silviculture Research Manual, Volume II, (The Statistical Code) are as follows:

(1) The determination of crop increment at all stages of development of even-aged crops.

(2) The comparison of crop increment of even-aged crops with the same origin and treatment but on different qualities of locality.

(3) The comparison of the influence on crop-increment of even-aged crops of different methods of regeneration and treatment.

The sample plot technique is based on Schwappach's height and form factor curve method. Before selection of sample trees, diameters (at breast height *i.e.*, 4½') and total heights of more than 12 typical trees, standing within the plot and distributed over the whole height and diameter range, are measured. With these data, a smooth Height/Diameter curve is drawn in the field. Then sample trees, not less than 6 and usually 10, covering the complete diameter range are selected so that when plotted their heights fall on the curve. This method facilitates the selection of representative sample trees even from the surround or outside the plot. Sample trees are generally selected from trees marked for thinnings; but whenever difficulty is felt in finding suitable trees, standing trees in the plot are selected as such and these trees are remeasured at every future remeasurement so long as they are suitable and fit for the purpose.

From the point of view of modern sampling technique, selection of at least 6 sample trees for estimating the whole crop of a sample plot by Schwappach's height and form factor curve method is open to objection. The defects of imperfect and inadequate sample trees were pointed out in the Fifth Silvicultural Conference in 1939 by M.V. Laurie, then Silviculturist F.R. I. Long before this, H.G. Champion has also admitted (in the preface of the aforesaid Silviculture Research Manual) that the sample plot technique followed in India is not based on sound mathematical theory.

So far, no one has tried to estimate the crop existing in a sample plot using purely statistical methods. In this paper, some of the clear-felled sample plots were taken up for study, more or less on the lines suggested by K.R. Nair, in his paper on 'Sampling Techniques' contributed to the *United Nations Economic and Social* Council, in April 1949. An attempt has been made to examine the precision by selection of sample trees at random from all the felled trees in a plot with and without stratification into several diameter groups. Besides this, it has also been examined how increase in the number of sample trees from 6 to 10, 15 and 20, enhances the precision.

The main factors for study should have been diameter, height and volume, but the study of the first character has been ignored purposely as the d.b.h. measurements can easily be taken and do not require much time. Total height and total (timber, smallwood and branchwood) volume are the two characters examined in this paper. The following five clearfelled sample plots were selected at random :—

Table (1): List of clearfelled sample plots

Division, Province	S.P. No.	Species	Year of clear-felling	Age	Total No. of trees in the plot.
Montgomery, Punjab	5	*Dalbergia sisso*	1934	15	138
—do —do—	8	—do—	1934	15	230
Lahore, Punjab	27	*Morus, alba*	1934	14	88
Ramnagar, U.P.	36	*Shorea, robusta*	1934	102	58
Buxa, Bengal	1	—do—	1927	74	44

Results of unrestricted random sampling.

With the help of random numbers given by Fisher and Yates in their "Statistical Tables for biological, agricultural and medical research", 4 unrestricted random samples of sizes 6, 10, 15 and 20 were taken from the total felled trees of each of the plots, and from these samples mean and standard deviation were computed for both total heights and total volumes. Actual crop figures and those derived from the 'samples of choice' selected by the 'sample plot parties' are shown side by side with the results of these unrestricted random samples in table Nos. 2-6.

The mean and the standard deviations have been calculated in the usual way; but the standard error of the mean for each sample size has been computed (without utilising the actual sample observations) with the help of the formula:

$$\text{S.E. of the mean} = \sqrt{\frac{\sigma^2}{n}\,\frac{N-n}{N-1}}, \text{ where}$$

σ^2 = the variance of the whole sample plot population,

n = the number of trees in the sample and
N = the number of trees in the whole plot.

A careful study of these tables reveals that with the exception of the mean volume of S.P. No. 27 all the other mean height and volume figures derived from 'sample of choice' (cols 4 & 5) for each of the sub-plots, are higher than the actual figures as well as those obtained by random sampling with different intensities. This clearly shows that the present method of sampling is not free from bias.

In these tables we also observe as is expected, that with increase in the size of a random sample, the estimated height and volume means gradually approach the population values and the precision is also enhanced.

Variance of the mean volume for each of the sample sizes of the clearfelled plots under study, as calculated by the formula:

$$V(\bar{x}) = \frac{\sigma^2}{n}\,\frac{N-n}{N-1}$$

is given in Table (7), simply to show that the bigger the sample size, the less is the variance of the mean and the nearer we approach the actual value.

Graphs for variance of the mean volume/sample size (n) have also been drawn for all the plots separately on page 14 graph. A glance at Table (7) and these graphs makes it easy to understand how increase in the sample size reduces the variance of the mean volume.

Sample Plot No. 5, Montgomery Division, Punjab

Table (2): *Dalbergia sissoo* : **Total height** (**in ft.**) **and total wood volume *** (**in c. ft.**) **of individual trees selected under different sampling schemes.**

	Total crop after clearfelling			Sample of choice, 7 trees measured from thinnings		4 unrestricted random samples of different sizes							
						6		10		15		20	
	No. of trees in the plot	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	138	52	14.8	51	10.4	46	4.6	39	3.5	44	4.0	37	3.2
		50	10.1	52	8.6	44	8.1	50	7.5	32	1.4	30	0.9
		49	10.2	49	8.1	38	2.1	42	2.5	37	1.7	37	1.7
		..	..	45	5.9	38	1.7	39	3.3	49	10.2	29	1.3
		..	..	43	4.3	43	4.3	36	2.0	52	8.6	49	10.2
		..	..	41	3.3	52	14.8	39	2.5	46	7.4	46	8.1
				41	2.2			42	2.5	39	2.5	48	5.2
								46	3.6	50	10.1	38	1.7
								49	6.2	37	3.2	33	0.9
								34	2.2	41	2.8	37	2.6
										44	2.3	40	2.6
										36	1.5	46	4.0
										46	6.3	45	5.3
										42	3.6	36	1.8
		..	..							45	5.3	47	4.3
		..	..									40	4.7
		..	..									32	3.5
		37	1.5									52	6.7
		30	0.9									46	4.1
		33	0.9									48	7.4
Mean	..	43.3	4.8	46.0	6.1	43.5	5.9	41.6	3.6	42.7	4.7	40.8	4.0
S.D.	..	5.63	2.84	4.65	3.03	5.28	4.89	5.32	1.83	5.68	2.79	6.89	2.56
S.E. of the mean	..	..	..	2.081	1.050	2.256	1.138	1.721	0.868	1.377	0.695	1.168	0.589

* Timber, smallwood and branchwood volume.

Sample Plot No. 8, Montgomery Division, Punjab

Table (3): *Dalbergia sissoo*: **Total height (in ft.) and total wood volume * (in c. ft.) of individual trees selected under different sampling schemes.**

	Total crop after clearfelling			Sample of choice, 12 trees measured from thinnings		4 unrestricted random samples of different sizes							
						6		10		15		20	
	No. of trees in the plot	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	230	53	15.8	54	12.4	38	1.4	46	5.4	46	5.4	40	3.3
		46	13.4	57	11.6	42	2.8	52	12.0	45	4.6	57	9.3
		51	15.4	58	10.1	47	3.7	41	3.7	40	3.3	50	6.9
		..	..	57	9.3	47	6.2	42	4.9	48	4.2	54	12.4
		..	..	52	9.5	57	9.3	46	5.1	48	6.0	47	3.3
		..	..	48	6.8	48	8.5	54	8.9	41	3.2	42	3.6
				46	5.1			43	3.7	46	9.4	43	1.6
				47	4.9			33	2.4	58	10.1	39	1.4
				45	4.2			40	2.8	42	4.9	48	4.2
				47	3.2			44	4.0	57	9.3	51	8.5
				39	2.9					47	5.5	42	2.9
				32	0.9					55	14.5	48	6.8
										44	4.4	45	5.6
		..	..							47	6.5	50	9.2
		..	..							50	9.9	25	0.4
		..	..									33	1.4
		25	0.4									50	8.9
		24	0.4									50	5.7
		22	0.3									47	4.8
												54	6.0
Mean		45.1	5.5	48.5	6.7	46.5	5.3	44.1	5.3	47.6	6.7	45.8	5.3
S.D.		6.68	3.04	8.86	3.75	6.41	3.20	5.99	2.97	5.45	3.20	7.55	3.22
S.E. of the mean		..	..	1.881	0.856	2.697	1.227	2.070	0.942	1.671	0.761	1.430	0.651

* Timber, smallwood and branchwood volume.

Sample Plot No. 27, Lahore Division, Punjab

Table (4) : *Morus alba*: **Total height (in ft.) and total wood volume* (in c. ft.) of individual trees selected under different sampling schemes.**

	Total crop after clearfelling			Sample of choice, 6 trees measured from thinnings		Four random samples of different sizes							
						6		10		15		20	
	No. of trees in the plot	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	88	58	19.7	55	14.8	55	14.8	48	6.7	54	10.1	39	5.8
		63	20.3	57	12.2	47	7.3	50	3.7	38	4.2	51	10.1
		53	18.8	52	10.8	51	7.5	61	21.2	52	8.2	40	3.2
		..	..	53	9.2	57	17.6	55	17.7	50	5.5	48	6.7
		..	..	49	5.6	51	13.3	63	20.3	53	9.8	49	3.3
		..	..	49	3.3	40	3.2	51	5.5	54	13.1	55	17.7
								41	2.6	53	18.8	51	5.5
								54	10.1	27	1.6	27	1.8
								39	5.8	50	2.9	48	10.3
								44	9.7	52	10.8	44	5.8
										26	0.8	51	7.9
										55	9.3	50	2.9
										48	5.9	57	17.6
										44	6.4	54	14.2
										49	5.6	50	8.7
		..	..									56	8.0
		..	..									38	4.2
		27	1.6									43	7.9
		27	1.8									50	5.2
		26	0.8									43	3.3
Mean		48.9	8.3	52.5	9.3	50.2	10.6	50.6	10.3	47.0	7.5	47.2	7.5
S.D.		7.67	4.72	3.21	4.26	6.08	5.46	7.96	6.94	9.40	4.70	7.29	4.60
S.E. of the mean		..	..	3.040	1.871	3.040	1.871	2.297	1.413	1.814	1.116	1.516	0.933

* Timber, smallwood and branchwood volume

Sample Plot No. 36, Ramnagar Division, U.P.

Table (5): *Shorea robusta*: **Total height (in ft.) and total wood volume* (in c. ft.) of individual trees selected under different sampling schemes.**

	Total crop after clearfelling			Sample of choice, 7 trees measured from thinnings		Four random samples of different sizes							
						6		10		15		20	
	No. of trees in the plot	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	58	118	146.6	118	146.6	92	27.8	111	57.4	105	84.2	105	104.3
		103	154.2	110	124.2	98	91.0	101	28.9	109	71.6	110	124.2
		118	141.7	108	94.6	102	65.8	100	54.0	114	54.4	92	48.1
		..	..	110	106.5	105	84.2	110	98.2	111	57.4	101	48.2
		..	..	99	70.4	100	47.7	111	65.2	105	70.5	104	66.2
		..	..	101	47.2	92	48.1	104	57.4	110	124.2	102	65.8
				105	52.5			105	52.5	92	37.8	108	64.1
								98	45.9	101	50.0	110	95.7
								109	63.3	98	45.9	103	59.7
								104	66.2	103	154.2	110	106.5
										111	102.9	101	87.5
										103	55.4	98	45.9
										103	70.3	109	92.3
		..	..							111	56.1	100	54.0
		..	..							101	48.2	102	77.2
		..	..									92	37.8
		92	37.8									111	65.2
		97	30.4									105	84.2
		101	28.9									96	61.5
												103	70.3
Mean		104.7	72.9	107.3	91.7	98.2	60.8	105.3	58.9	105.1	72.2	103.1	72.9
S.D.		6.03	28.22	6.37	36.05	5.31	24.11	3.28	17.62	5.93	32.23	5.69	23.04
S.E. of the mean		..	..	2.156	10.089	2.351	11.004	1.750	8.189	1.352	6.329	1.101	5.152

* Timber, smallwood and branchwood volume

Sample Plot No. 1, Buxa Division, Bengal

Table (6): *Shorea robusta*: **Total height (in ft.) and total wood volume* (in c. ft.) of individual trees selected under different sampling schemes.**

	Total crop after clearfelling			Sample of choice 6 trees measured from thinnings		Four random samples of different sizes							
						6		10		15		20	
	No. of trees in the plot	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)	Total ht. (in ft.)	Total vol. (in c.ft.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	44	98	81.8	98	81.8	73	16.2	79	43.2	86	45.2	79	36.3
		89	45.4	89	45.4	84	43.2	86	31.0	86	26.5	73	15.1
		86	45.2	86	39.1	73	15.1	82	23.4	70	12.9	76	23.2
		..	..	79	28.0	64	14.1	81	34.2	82	32.8	81	34.2
		..	..	73	15.1	76	23.2	89	45.4	73	15.1	86	31.0
		..	..	71	13.7	70	18.9	65	11.6	64	14.1	59	9.1
								73	20.4	82	23.4	79	26.6
								71	13.7	53	9.0	78	26.9
								69	12.1	70	18.9	70	18.9
								79	20.3	79	33.3	85	28.0
										86	38.3	84	43.2
										79	28.0	86	38.3
										85	26.2	67	17.3
										79	20.3	65	11.6
		..	..							72	19.9	79	20.3
		..	..									86	39.1
		..	..									72	19.9
		71	13.7									71	16.5
		59	9.1									79	33.3
		53	9.0									70	12.9
Mean		76.9	26.1	82.7	37.2	73.3	21.8	77.4	25.5	76.4	24.3	76.3	25.1
S.D.		8.84	13.26	10.29	25.24	6.62	10.99	7.69	12.40	9.44	10.09	7.68	8.30
S.E. of the mean		..	..	3.393	5.090	3.393	5.090	2.486	3.729	1.874	2.812	1.477	2.215

* Timber, smallwood and branchwood volume

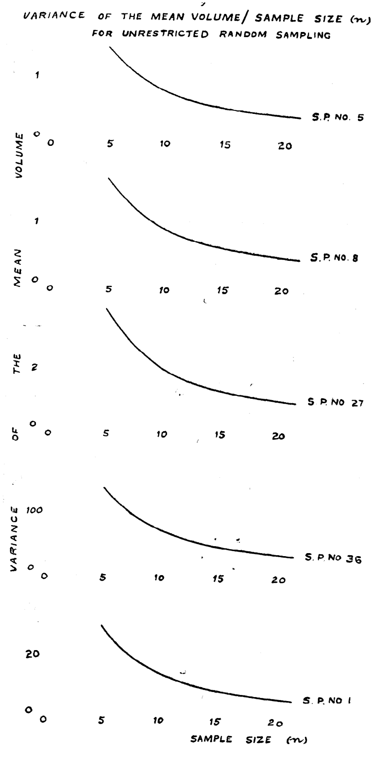

VARIANCE OF THE MEAN VOLUME/ SAMPLE SIZE (n)
FOR UNRESTRICTED RANDOM SAMPLING
VARIANCE OF THE MEAN VOLUME
S.P. NO. 5
S.P. NO. 8
S.P. NO 27
S.P. NO 36
S.P. NO 1
1
0
1
0
2
0
100
0
20
0
0
5
10
15
20
SAMPLE SIZE (n)

Table (7) : **Variance of the mean volume for different sample sizes under unrestricted random sampling scheme.**

Sample plot No. \ Sample size	6	10	15	20
5	1.30	0.75	0.48	0.35
8	1.51	0.89	0.58	0.42
27	3.50	2.00	1.25	0.87
36	121.09	67.06	40.06	26.54
1	25.91	13.91	7.91	4.91

Due to much variation between tree volumes, standard deviation of the volume, in each case, is very high. In most cases, it is even more than half the mean volume. As our study of volume includes standard timber volume (calculated by full basal area excluding bark) of logs with a minimum diameter of 8″ over bark at the thin end and stem and branch small wood volume (calculated by full basal area including bark) of logs from 8″-diameter over bark down to 2″-diameter over bark, the total wood volumes are bound to differ according to the size, shape and timber and smallwood bole lengths of a tree. Anyhow, the volumes can be split up into timber volume and total smallwood volume and studied as two different characters under the stratified random sampling scheme.

Results of stratified random sampling.

Under this sampling scheme, the tree population of a sample plot was stratified into 5 diameter classes and random sampling observations were drawn from each of them. Three samples of 10, 15 and 20 were selected by drawing 2, 3 and 4 trees from each of the diameter classes. As it is not possible to compute the precision by taking only one tree from each diameter group, a samble of 6 was not taken under this sampling scheme. The results of the representative or stratified random sampling design are shown in Table nos. 8-12.

By way of illustration, let us explain the calculations of table 8 (a). Columns 1-3 do not require any explanation; column 4 gives standard deviation for each of the diameter groups as well as for the combined groups ; columns 5-7 contain results of a representative set of samples drawn from the sample plot population by selecting 2 trees at random from each diameter class ; column 5 gives mean height for each diameter group. The general mean for the combined groups has been computed on the basis of weighted means of the various strata. Taking the actual figures, general mean—

$$= \frac{(37.5\times25)+(38.5\times47)+(49.5\times36)+(48.0\times27)+(51.0\times3)}{(25+47+36+27+3)}$$

$= 43.3$

In column 6, standard deviation is calculated after slight correction for the limited population of each diameter group using the formula :

$$\text{S.D.} = \sqrt{V\frac{(N-1)}{N}}, \text{ where}$$

$V =$ the variance of the sample from a diameter class.

and $N =$ the number of trees in the diameter class.

Column 7 gives the standard error of the mean for each diameter class. It is computed with the help of the formula :

$$\text{S.E. of the mean} = \sqrt{\frac{V}{n}\left(\frac{N-n}{N}\right)}, \text{ where}$$

$V =$ the variance of the sample from a diameter class,

$n =$ the size (number of trees) of a sample (in this case $n=2$) and

$N =$ the size (number of trees) of the whole diameter group.

S.P. No. 5, Montgomery Division, Punjab.

Table 8a.—*Dalbergia sissoo*: **Comparison of actual and estimated heights (ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean height of trees	S.D.	Results of stratified random sampling								
				2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
3.1—4.5	25	36.4	4.11	37.5	0.69	0.481	38.7	3.96	2.188	37.5	3.62	1.695
4.6—6.0	47	41.1	3.76	38.5	2.10	1.464	42.3	3.48	1.963	44.0	2.80	1.355
6.1—7.5	36	45.8	3.10	49.5	0.70	0.488	43.7	3.74	2.090	47.0	2.54	1.215
7.6—9.0	27	49.3	2.84	48.0	1.39	0.962	47.3	1.50	0.831	47.3	2.70	1.270
Over 9.0	3	50.3	1.53	51.0	1.15	0.573	50.3	1.53	0	50.3	1.53	0
Combined	138	43.3	5.63	43.3	..	0.555	43.2	..	0.963	44.4	..	0.685

Table 8b.—*Dalbergia sissoo*: **Comparison of actual and estimated total volumes * (c. ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean volume of trees	S.D.	Results of stratified random sampling								
				2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
3.1—4.5	25	1.7	0.39	1.8	0.07	0.049	2.1	0.48	0.266	1.6	0.47	0.220
4.6—6.0	47	3.1	0.74	2.4	0.07	0.049	3.4	0.17	0.098	3.4	0.76	0.365
6.1—7.5	36	5.5	1.08	6.3	0.21	0.148	4.4	0.68	0.381	5.7	0.90	0.430
7.6—9.0	27	8.8	1.19	9.2	1.46	1.011	7.9	0.40	0.219	8.1	0.52	0.245
Over 9.0	3	11.7	2.70	12.5	2.71	1.916	11.7	2.70	0	11.7	2.70	0
Combined	138	4.8	2.84	4.9	..	0.206	4.5	..	0.123	4.8	..	0.179

* Timber, smallwood and branchwood volume.

S.P. No. 8, Montgomery Division, Punjab.

Table 9a.—*Dalbergia sissoo*: **Comparison of actual and estimated heights (ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean height of trees	S.D.	Results of stratified random sampling								
				2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
2.1—4.0	11	30.9	6.25	30.5	7.45	4.978	27.3	4.80	2.483	31.0	5.78	2.415
4.1—6.0	69	40.0	4.52	40.5	0.70	0.490	38.3	7.18	4.088	41.0	4.13	2.020
6.1—8.0	98	47.0	3.38	43.0	2.82	1.980	47.3	2.07	1.189	44.5	3.68	1.810
8.1—10.0	46	51.3	3.87	50.5	3.50	2.447	48.3	3.75	2.113	50.0	4.50	2.175
10.1—12.0	6	51.7	3.08	53.5	1.94	1.223	50.7	4.12	1.842	51.5	3.53	1.120
Combined	230	45.1	6.68	43.4	..	1.015	43.9	..	1.398	44.1	..	1.080

Table 9b.—*Dalbergia sissoo*: **Comparison of actual and estimated total volumes * (c. ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean volume of trees	S.D.	Results of stratified random sampling								
				2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
2.1—4.0	11	0.9	0.47	0.9	0.61	0.375	0.5	0.31	0.141	0.8	0.48	0.141
4.1—6.0	69	2.8	0.73	2.9	0.49	0.346	2.5	1.19	0.667	2.9	0.89	0.428
6.1—8.0	98	5.8	0.88	4.5	0.42	0.297	6.1	1.15	0.660	5.8	1.46	0.716
8.1—10.0	46	9.4	1.46	9.6	1.68	1.181	8.1	0.83	0.474	8.8	1.51	0.742
10.1—12.0	6	13.9	1.55	13.2	1.61	1.131	14.4	0.92	0.495	13.1	0.99	0.432
Combined	230	5.5	3.04	5.1	..	0.289	5.4	..	0.358	5.5	..	0.363

* Timber, smallwood and branchwood volume.

S.P. No. 27, Lahore Division, Punjab.

Table 10a.—*Morus alba*: **Comparison of actual and estimated heights (ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean height of trees	S.D.	Results of stratified random sampling: 2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
3.1—5.0	10	35.5	8.97	38.0	14.76	9.836	33.0	6.80	3.481	39.3	9.40	3.840
5.1—7.0	20	45.1	5.15	44.5	7.58	5.218	46.7	5.63	3.071	41.3	2.01	0.920
7.1—9.0	36	50.8	3.67	57.5	3.49	2.432	49.7	3.17	1.778	51.3	3.81	1.820
9.1—11.0	17	54.8	2.86	56.5	0.69	0.467	53.3	2.96	1.599	54.0	2.74	1.235
11.1—13.0	5	58.0	4.12	60.5	3.16	1.937	55.3	2.25	0.918	59.3	3.17	0.780
Combined	88	48.9	7.67	52.3	..	1.915	48.1	..	1.127	48.6	..	0.921

Table 10b.—*Morus alba*: **Comparison of actual and estimated total volumes* (c. ft.) by stratified random sampling.**

Diameter class (inches)	No. of trees	Mean volume of trees	S.D.	Results of stratified random sampling: 2-trees per diameter class			3-trees per diameter class			4-trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
3.1— 5.0	10	2.2	0.71	2.6	1.01	0.672	2.0	0.50	0.254	2.2	0.89	0.290
5.1— 7.0	20	4.6	1.06	4.8	0.96	0.665	4.7	1.29	0.704	4.1	0.90	0.415
7.1— 9.0	36	8.3	1.59	8.2	1.53	1.068	7.5	0.64	0.358	8.2	1.62	0.770
9.1—11.0	17	13.0	2.00	11.7	0.69	0.467	12.2	0.79	0.421	12.2	1.36	0.615
11.1—13.0	5	19.5	1.35	20.0	0.38	0.233	18.7	0.90	0.364	19.7	1.33	0.330
Combined	88	8.3	4:72	8.1	..	0.477	7.8	..	0.234	8.0	..	0.352

*Timber, smallwood and branchwood volume.

S. P. No. 36, Ramnagar Division, U. P.

Table (11a.)—*Shorea robusta* : **Comparison of actual and estimated heights (ft.) by stratified random sampling.**

Diameter class (in inches)	No. of trees	Mean height of trees	S.D.	Results of stratified random sampling								
				2 trees per diameter class			3 trees per diameter class			4 trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
11.1—14.0	3	96.7	6.75	96.5	5.20	2.454	96.7	6.75	0	96.7	6.75	0
14.1—17.0	15	103.5	5.37	107.0	5.46	3.726	102.0	9.22	4.925	104.0	3.25	1.440
17.1—20.0	19	103.7	4.52	105.0	4.13	2.836	100.7	1.32	0.618	104.5	4.67	2.130
20.1—23.0	14	106.8	6.30	105.0	5.25	3.705	106.0	6.95	3.689	107.0	7.83	3.435
Over 23.0	7	109.6	4.51	114.5	4.51	2.956	106.3	3.25	1.536	112.0	10.03	2.635
Combined	58	104.7	6.03	106.2	..	1.615	102.3	..	1.578	105.5	..	1.158

Table (11b.)—*Shorea robusta* : **Comparison of actual and estimated total volumes* (c. ft.) by stratified random sampling.**

Diameter class (in inches)	No. of trees	Mean volume of trees	S.D.	Results of stratified random sampling								
				2 trees per diameter class			3 trees per diameter class			4 trees per diameter class		
				Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean	Mean	S.D.	S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
11.1—14.0	3	32.4	4.76	33.4	5.14	2.567	32.4	4.76	0	32.4	4.76	0
14.1—17.0	15	50.5	5.12	55.2	1.30	0.884	53.6	4.73	2.529	52.5	3.30	1.460
17.1—20.0	19	63.9	9.18	67.6	4.82	3.309	62.2	6.96	3.787	64.0	7.00	3.199
20.1—23.0	14	91.7	12.59	79.6	10.83	7.361	94.5	3.33	1.767	89.0	18.35	8.048
Over 23.0	7	125.0	23.71	122.3	25.40	16.398	123.0	29.50	1.391	126.6	19.42	6.865
Combined	58	72.9	28.12	72.1	..	2.884	73.6	..	1.475	73.0	..	2.388

* Timber, smallwood and branchwood volume.

S. P. No. 1, Buxa Division, Bengal.

Table (12a.)—*Shorea robusta*: **Comparison of actual and estimated heights (ft.) by stratified random sampling.**

Diameter class (in inches)	No. of trees	Mean height of trees	S.D.	Results of stratified random sampling: 2 trees per diameter class: Mean	2 trees: S.D.	2 trees: S.E. of the mean	3 trees per diameter class: Mean	3 trees: S.D.	3 trees: S.E. of the mean	4 trees per diameter class: Mean	4 trees: S.D.	4 trees: S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
7.1— 9.0	5	63.3	7.56	70.5	0.63	0.389	61.0	8.20	3.349	63.3	7.81	1.995
9.1—11.0	13	71.9	5.63	73.0	0	0	73.7	7.76	2.552	74.3	1.44	0.490
11.1—13.0	15	80.1	5.01	79.0	1.37	0.933	82.0	2.90	1.813	81.5	4.50	2.410
13.1—15.0	7	82.4	2.99	84.0	2.62	1.690	83.0	2.45	1.155	80.3	1.39	0.635
Over 15.0	4	89.0	6.48	86.0	3.67	2.121	90.0	6.54	2.177	89.0	6.48	0
Combined	44	76.9	8.84	77.7	..	0.461	78.0	..	1.080	77.8	..	0.870

Table (12b.)—*Shorea robusta*: **Comparison of actual and estimated total volumes* (c. ft.) by stratified random sampling.**

Diameter class (in inches)	No. of trees	Mean volume of trees	S.D.	Results of stratified random sampling: 2 trees per diameter class: Mean	2 trees: S.D.	2 trees: S.E. of the mean	3 trees per diameter class: Mean	3 trees: S.D.	3 trees: S.E. of the mean	4 trees per diameter class: Mean	4 trees: S.D.	4 trees: S.E. of the mean
1	2	3	4	5	6	7	8	9	10	11	12	13
7.1— 9.0	5	11.3	2.15	13.3	0.56	0.311	10.6	2.40	0.981	11.2	2.21	0.555
9.1—11.0	13	17.0	3.35	15.7	0.75	0.509	18.7	2.97	1.565	17.9	3.50	1.515
11.1—13.0	15	26.3	3.37	26.5	0.55	0.375	26.5	2.57	1.368	28.5	1.74	0.740
13.1—15.0	7	36.6	3.74	36.0	4.12	2.666	35.1	2.65	1.247	34.2	1.42	0.505
Over 15.0	4	54.4	18.24	45.3	0.18	0.106	57.4	18.28	6.091	54.4	18.24	0
Combined	44	26.1	13.26	25.0	..	0.469	26.6	..	0.889	26.7	..	0.524

* Timber, smallwood and branchwood volume.

The general S.E. of the mean for the combined diameter groups (in column 7) was calculated by using the formula, S.E. of the mean =

$$\sqrt{\frac{n_1^2\,V(\bar{x}_1)+n_2^2\,V(\bar{x}_2)+n_3^2\,V(\bar{x}_3)+n_4^2\,V(\bar{x}_4)+n_5^2\,V(\bar{x}_5)}{(n_1+n_2+n_3+n_4+n_5)^2}}$$

where n_1, $n_2 \ldots, n_5$ respectively are the numbers of trees in the first, second,.... and fifth diameter groups and

$V(\bar{x}_1)$, $V(\bar{x}_2), \ldots, V(\bar{x}_5)$ respectively are the variances of the mean of the first, second,....and fifth diameter classes.

Similarly, the rest of the calculations for the other representative sets of samples are computed in columns 8-10 and 11-13. The calculations of total volume in Table 8(b) are also done in the same way.

The results of Table nos. 8-12 suggest that the mean figures derived by stratified random sampling are much closer to the actual figures obtained by measuring the whole crop after clear felling, than those obtained by unrestricted random sampling. The maximum difference between the actual and the estimated mean height for S.P. No. 27 under sample size 10 is 6.9 per cent, while the maximum volume difference between the actual and the estimated figures for S.P. No. 8 under sample size 10 is 7.3 per cent. In no case is the difference more than 6 per cent for bigger sample sizes. As regards gain in precision, the graphs below clearly show that the variance of the mean height for stratified random sampling is much less than that for the unrestricted random sampling. For the former sampling scheme also, as an example, for S.P. No. 27, variance of the mean height for each of the diameter classes has been computed by the formula

$$V(\bar{x}i) = \frac{\sigma^2}{n} \times \frac{N-n}{N-1}$$

and the variance of the general mean calculated by the formula

$$V(\bar{x}) = \frac{n_1{}^2V(\bar{x}_1)+n_2{}^2V(\bar{x}_2)+\ldots+n_5{}^2V(\bar{x}_5)}{(n_1+n_2+\ldots+n_5)^2}$$

Table No. 13 gives variance of the mean height under different sample sizes for the sampling schemes with and without stratification.

Table (13): *Comparison of the variance of the mean height derived by unrestricted random sampling and stratified random sampling for S.P. No. 27, Lahore dn. Punjab.*

Sampling scheme \ Sample size	6	10	15	20
Unrestricted random sampling	9.242	5.276	3.291	2.298
Stratified random sampling	..	2.369	1.484	1.042

Table nos. 8-12 have been further summarised and final results given in Table nos. 14 and 15.

These Tables contain actual mean figures, estimated mean, S.E. of the mean and 95 per cent confidence intervals calculated from

$\bar{X} \pm 1{\cdot}96 \frac{s}{\sqrt{n}}$, where

$\bar{X}$ = the estimated mean,

$1{\cdot}96$ = the 5 per cent point of normal distribution and $\frac{s}{\sqrt{n}}$ = the S.E. of the mean.

Here we observe that the bigger the sample size, the closer are the 95 per cent confidence intervals; especially under sample size 20, the limits are very close to one another. Now, on evidence we can assert that the actual mean of a sample plot lies between $\bar{X} \pm 1{\cdot}96 \frac{s}{\sqrt{n}}$ (*i.e.* between the limits given in columns 5, 8 and 11 of the Tables 14 & 15), the risk of our assertion being false by 5 per cent.

We also observe that the results derived from the 'sample of choice' (columns 4 & 5 of tables 2—6) are higher than these mean figures obtained by stratified random sampling design.

[The current method of sample plot calculation based on Schwappach's Height and Form factor curve method is

VARIANCE OF THE MEAN HEIGHT/SAMPLE SIZE, FOR UNRESTRICTED RANDOM SAMPLING AND STRATIFIED RANDOM SAMPLING IN S. P. No. 27

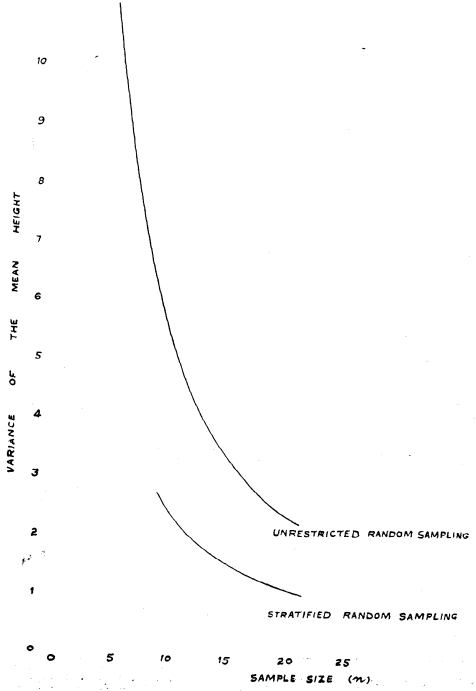


Table (14) : Comparison of the actual and estimated mean height

S. P. No.	Actual mean height (ft.)	Size of the stratified random sampling								
		10			15			20		
		Mean height (ft.)	S.E. of the mean	95% confidence limits	Mean height (ft.)	S.E. of the mean	95% confidence limits	Mean height (ft.)	S.E. of the mean	95% confidence limits
1	2	3	4	5	6	7	8	9	10	11
5	43.3	43.3	.555	42.2— 44.4	43.2	0.963	41.3— 45.1	44.4	0.685	43.1— 45.7
8	45.1	43.4	1.015	41.4— 45.4	43.9	1.398	41.2— 46.6	44.1	1.080	42.0— 46.2
27	48.9	52.3	1.915	48.5— 56.1	48.1	1.127	45.9— 50.3	48.6	0.921	46.8— 50.4
36	104.7	106.2	1.615	103.0—109.4	102.8	1.578	99.7—105.9	105.5	1.158	103.2—107.8
1	76.9	77.7	0.461	76.8— 78.6	78.0	1.080	75.9— 80.1	77.8	.870	76.1— 79.5

Table (15) : Comparison of the actual and estimated mean volume

S. P. No.	Actual, mean volume (c. ft.)	Size of the stratified random sampling: 10			15			20		
		Mean volume (c.ft.)	S.E. of the mean	95% confidence limits	Mean volume (c.ft.)	S.E. of the mean	95% confidence limits	Mean volume (c.ft.)	S.E. of the mean	95% confidence limits
1	2	3	4	5	6	7	8	9	10	11
5	4.8	4.9	.206	4.5— 5.3	4.5	.123	4.3— 4.7	4.8	.179	4.4— 5.2
8	5.5	5.1	.289	4.5— 5.7	5.4	.358	4.7— 6.1	5.5	.363	4.8— 6.2
27	8.3	8.1	.477	7.2— 9.0	7.8	.234	7.3— 8.3	8.0	.352	7.3— 8.7
36	72.9	72.1	2.884	66.4—77.8	73.6	1.475	70.7—76.5	73.0	2.388	68.3—77.7
1	26.1	25.0	.469	24.1—25.9	26.6	.889	24.9—28.3	26.7	.524	25.7—27.7

open to statistical objection. Differences of opinion are likely to arise in drawing the height and form-factor curves with the help of a limited number of sample trees. This difficulty can probably be overcome by applying the Stratified Random Sampling Scheme with a larger number of sample trees as described in the above paper. By merely increasing the number of sample trees and applying Schwappach's method we are not likely to get greater precision because our selection of sample trees is likely to be biased. However, the fact remains that even by the Stratified Random Sampling Scheme a fairly large number of sample trees has to be measured to achieve a fairly high degree of precision, which may not be always practicable in the field. K.K.]

ON THE ECOLOGY AND SILVICULTURE OF *DENDROCALAMUS STRICTUS* IN THE BAMBOO FORESTS OF BHADRAVATI DIVISION, MYSORE STATE, AND COMPARATIVE NOTES ON THE SPECIES *BAMBUSA ARUNDINACEA*, *OXYTENANTHERA MONOSTIGMA* AND *OXYTENANTHERA STOCKSII*

BY DR. K. KADAMBI, MYSORE FOREST SERVICE

(*Continued from Sept. 1949 Issue*)

The following is a brief description of experimental work conducted in Mysore and the observations made :—

Dendrocalamus strictus

(A) Experimental Plot No. 1.

Opened :—May 1936.

Locality :—Kukwada-Ubrani State forest near Gangur.

Average rainfall :—30 inches.

Number of clumps under observation :—89.

(1) **Original treatment :—**All dry bamboos removed; fellings of the intensity of 100 per cent (clearfelling), 75 per cent., 50 per cent and 25 per cent done in June 1937. The culms were cut flush with the ground surface. One year culms were, as far as practicable, not cut.

(2) **Results :—**

(i) **Clearfelled clumps :—**Out of the 19 clumps treated 11 showed no signs of life in the first year (1937) and 3 more in the next year. All the annual culms of the remaining 4 clumps, produced till 1939, were switchy or under-developed. In 1940, only 3 out of the 22 culms produced were of normal size. Clump No. 9 started flowering. This clump was in full flower in 1941 and died soon after. Only 10 bamboos were given off from the remaining three clumps (Nos. 6, 15 and 17) in 1941, all being normal. The three living clumps contain in all 55 culms of which only 13 are of normal size against 505 culms cut at the time of clearfelling.

(ii) **The 75 per cent felled clumps :—** About 40 per cent of the new culms produced in the two seasons after felling (1937 and 1938) were under-developed. In 1939, about 60 per cent of the culms produced were under-developed, a change for the worse, owing probably to the very dry season of 1938. In 1940, about 77 per cent of the new culms were normal and in 1941 nearly all were normal. The clump regained the original (initial) number of culms in 1939 but a large proportion of the new culms were still under-developed or switchy.

(iii) **The 50 per cent felled clumps :—** Here about 25 per cent and 12 per cent of the new culms were under-developed or switchy in 1937 and 1938 respectively. In 1939 there was a set-back and about 36 per cent were under-developed or switchy. In 1940, again, about 13 per cent were under-developed or switchy; for the first time in 1940 all the new culms were normal. The clump regained the original number of normal culms in 1940.

(iv) **The 25 per cent felled clumps :—** These produced culms of the usual size (all normal) from the beginning, *i.e.*, from 1937 onwards. In 1939 there was a high proportion of under-developed and switchy culms owing probably to the dry weather of 1938. The clumps regained the initial number of normal culms in 1939.

(v) **Control clumps**, *i.e.*, those in which no fellings were done :—

Here all the new culms produced were of normal size from the very first year after the treatment.

(3) **Other observations made :—**

(i) Thinnings generally (except clear-cutting) stimulated the production of new culms, the culms appearing in larger numbers, earlier in the season and growing probably more rapidly than in unfelled clumps (control).

(ii) The appearance of thin, switchy shoots with bushy outgrowths at the nodes bearing dimunitive leaves resembling what is commonly called " witches broom " is an almost sure sign of exhaustion of food materials in the underground rhizome, which may result in the death of the clump.

(B) Experimental plot No. 2.

Locality :— Adjoining Kambadhal plantation near Gangur (Kambadhal plantation experimental plot).

Opened :—May 1936. Average rainfall—30 inches.

Number of culms under observation.—50.

(1) **Original treatment :—**All dry bamboos removed; fellings done in June 1937 of the intensity of 100 per cent, 75 per cent, 50 per cent, the culms felled being cut some at waist-height, some at knee-height and others at ground level, haphazardly, to imitate the method of cutting of license holders and forest coolies.

(2) **Results :—**

(i) **Clearfelled clumps:—**There were 12 such clumps. Their behaviour after the cutting varied from clump to clump. Most of those, in which a few culms cut at breast height and knee height remained behind after felling, showed signs of life immediately after the cutting and produced a few switchy shoots. This was particularly noticeable in the case of clump Nos. 2, 4, 5 and 7 where 7, 36, 26 and 34 culms cut at breast height had been left behind. These produced 15, 8, 6 and 2 culms respectively, of which, in the last two cases, the culms were of normal size. Clump No. 1, which had 15 culms cut at breast height and showed no signs of life in the growing season after the cutting (1937 rains), revived in the second season (1938 rains). By 1940 six clumps in all were found dead. In December, 1942, six out of the twelve clumps treated were found living, but the bamboo culms in many of them were still largely switchy or under-developed. There were in all, only 164 living culms against 487 cut at the time of clearfelling. It was found that, from among the culms cut at chest height and knee height, the one year old culms gave off long and whiplike lateral branches and these grew not laterally, as usual, but more or less erect and also gave off secondary branchlets with a conspicuous, if not copious, cover of leaves. Culms two or more years old did not show any such development. This seems to be obviously an attempt on the part of culms to divert the growth of the culm lost, to its side branches, which consequently develop strongly and bear a more copious cover of leaves. Although half the number of clumps treated are still living they seem to have been lastingly injured by the clear-cutting.

(ii) **The 75 per cent felled clumps :—** Twelve clumps were treated to 75% fellings, the cutting being mixed chest-height, knee-height and flush with the ground. As in research plot No. 1, none of the treated clumps died. In contrast to it, however, about 30 per cent of all new culms produced were of *normal* size in the very first season after the felling (1937), and about 75 per cent were normal in the next year. There was a setback in 1939, when out of the 54 annual culms only 16 were normal, and this was presumably due to the unusually dry season of 1938 or to fire. In 1939 only 3 out of the 27 annual culms were undersized and in 1941 all the 35 annual culms were normal. By the end of 1940 the clumps had regained the initial number of culms (*i.e.*, number found at the time of felling).

(iii) **The 50 per cent felled clumps :—** In the growing season immediately after the felling (1937 rains) about 25 per cent of the number of annual culms were switchy. In 1938 almost all the annual culms were normal, but there was a setback in 1929 when about 33 per cent of the new culms were switchy or under-developed, owing probably to the very dry preceding season. In 1940, again, most of the annual culms were normal and a few under-developed, but none switchy. The clumps regained the initial number of culms by the end of 1939, *i.e.*, one year before the 75% felled clumps.

(iv) **The 25 per cent felled clumps :—** All the annual culms produced in the first season after the felling were *normal* ; so also in all the succeeding seasons except in 1939 when about 10 per cent of the clums were switchy or under-developed. This is, probably, owing to the dry season of 1938. By 1938 the clumps had got back their initial number of normal culms.

(C) Experimental Plot No. 3.

Locality :— Kukwada-Ubrani state forest near Gangur, about a mile from the Gangur bungalow on the Nagenhalli cart-track to the left of the cart-track about a hundred yards away. This plot adjoins Research plot No. 1 to its east.

Area :—3 ch. × 6¼ chain or 1.875 ac.

Rainfall :—About 30 inches.

Forest :—Mixed-deciduous, Mysore quality III.

Date of opening and treatment :—June 1938.

(1) **Initial treatment :—**Plot divided into 5 blocks (blocks I to V), each 3 ch. by $1\frac{1}{2}$ ch. The natural forest trees were all effectively girdled and the bamboo growth *thus freed of all overhead forest cover.*

In blocks I to IV, all dead bamboos were cut away and felling of the intensities of 100 per cent (clear-cutting) 75 per cent, 50 per cent and 25 per cent of the number of living culms was done. Cutting was done at the level of the lowest node possible. In block V no green fellings were done but all dead bamboos were cut away to serve as control. The green fellings were, as far as practicable, confined to the oldest culms available and done on a thinning principle. The allotment of the treatments to the blocks was done at random.

(2) **Results :—**

(i) **Block I :—**(clearfelled block.)—Number of clumps treated—35 with 464 green culms, of which two, namely, numbers 23 and 24, were of *Bambusa arundinacea.* In 1938 (year of clearfelling) all except two clumps (Nos. 1 and 8) showed no signs of life. These two gave off one switchy culm each.

In 1939 four more showed life—Nos. 13, 19, 24 and 35. In 1940 five more showed signs of life, thus making a total of 11 clumps. At the end of 1941 there were, in all, only 35 culms in the block of which all except 7 were switchy or under-developed. The surviving clumps were seen struggling against death.

The two switchy culms of 1938 were thin, struggling ones with witches—broom like nodal outgrowths and dimunitive leaves. The culms given off in 1939 and 1940 were also switchy or under-developed. Some normal culms were produced in 1941. There were two clumps of *Bambusa arundinacea* in the block (Nos. 23 and 24) which also did not survive the clear-cutting.

(ii) **Block II :—**A 75% thinning was carried out in 1938 after removing all tree cover over the bamboo. In the year of thinning only about 1 in every 6 new culms were normal, the rest being switchy or under-developed. In 1939 only one in every 13 culms were normal. This low figure is probably due to the very dry season of 1938. In 1940 most new culms were normal, and the clumps nearly regained their original number of normal culms also. By 1941 they were fit for a second felling of the same intensity as the first.

(iii) **Block III :—**A 50% thinning was done in 1938. Most new culms were normal in the very first year, but owing to very unfavourable seasonal conditions nearly 45 %of the culms were switchy or under-developed in 1939. In 1940 nearly all new culms were normal, and the clumps had also regained their original number of normal culms.

(iv) **Block IV :—**A 25% thinning was done in 1938. New culms were normal from the very first season, and the original number of culms was regained in 1939, *i.e.*, within two growth seasons.

(v) **Block V :—**No green fellings were done ; only dead bamboos were cut away in 1938. The new culms were normal during all the years except in 1939, in which about 60 per cent of the new culms were under-developed or switchy owing probably to the very unfavourable seasonal conditions of 1938.

(D) Experimental Plot No. 4.

Locality:—About 100 yards from the 3rd mile stone on the Kodihalli-Burz forest road.

Opened:—May 1936 **Average rainfall**—60 inches.

(1) **Initial treatment :—**The plot after demarcation was divided into three equal blocks of each 4 sq. chains, and cuttings of the intensities of 33 per cent and 66 per cent of the green culms were done in blocks I and II respectively after removing all the dead bamboos. Block III was left unfelled as control. The allotment to the treatments was at random. The following results were obtained.

(2) **Results :—**

Block 1 :—Felling intensity 33 per cent in May 1937—This block contained originally 31 clumps of which 11 had to be climinated at a later stage as they were destroyed by an accidental fire. The culms produced after felling were mostly *normal* from the first year onwards, but in 1939, probably as a result of the drought of 1938, nearly 2/3rd number of new culms were under-developed or switchy. In 1940, too, a few culms were under-developed. All the culms were again normal in 1941. The clumps regained the initial number of

culms in 1939 but a large number of the culms died later owing probably to the dry weather in 1938-1939.

Block 2 :—Felling intensity 66 per cent in May 1937.

About one half the total number of culms produced in the first growing season after the felling (1937) were switchy or under-developed. In the second season most of the culms produced were normal. In 1939 about 43 per cent of the new culms were under-developed or switchy presumably owing to the preceding dry season. In 1940 and 1941, too, a few culms were under-sized. The clumps regained the original (initial) number of culms in 1940 but accidental casualties during the year were heavy which reduced this number unduly during that year.

(iii) **Block 3 :—**Control block. No fellings were made but dead bamboos were cut away from the clumps. The number of annual culms increased greatly in all years—following the initial treatment except in 1939 when this number was not appreciably higher presumably owing to the dry season of 1938. In 1939, also, about 40 per cent of the culms produced were under-developed or switchy. There were 32 clumps in the block of which 4 had to be eliminated at a later stage as they dried up owing to maltreatment as a result of quarrying metal too close to the rhizome.

(E) **Experimental Plot No. 5.**

Locality :— About 100 yards from the 3rd mile stone on the Kodihalli-Burz forest road adjoining Experimental Plot No. 4 to the south.

Opened :—May 1936. **Average rainfall**—65 inches. **Aspect**—Southern.

Drainage :—good.

(1) **Initial treatment**:—The plot, after demarcation, was divided into three equal blocks of each 4 sq. chains, and fellings of the intensities of 33 per cent and 66 per cent, were done in blocks V and VI respectively while block III was left unfelled as control. Simultaneously with the above operation all forest trees in the blocks were girdled effectively to remove overhead shade completely. The allotment to treatments was at random.

The following results were obtained :—

(2) **Results :—**

(i) **Block V :—**Felling intensity 33% in May 1938. This block contains 27 clumps. The new culms produced in the season after the felling (1938 rains) were mostly normal but in the next season (1939 rains) about 20% of the new culms were under-developed owing probably to the very dry summer of 1938. The new culms from 1940 onwards were normal. The clumps regained the original number of culms at the end of the growing season of 1939, *i.e.*, after two growing seasons.

(ii) **Block VI :—**Felling intensity 66 per cent. in May 1938—very few new culms, produced in the first growing season after the felling (1938 rains), were under-developed, but in 1939 about 26 per cent of the new culms were abnormal, mostly switchy, and this has to be attributed probably to the very dry growing season of 1938. The clumps regained the original number of culms in 1941, *i.e.*, in 3 growing seasons after the felling.

(iii) **Block IV :—**Control block. No green fellings were made but only dead bamboos were removed from the clumps in May 1938. There was increased production of new culms in the year immediately following the felling and the new culms were all normal except in 1939 when, probably as a result of the dry growing season of 1938, many culms were under-developed.

Tentative results of the experiments.

(i) **Longevity of culms.**

The number of culms dead with their respective ages (A.B. etc.) were recorded each year under the following heads for all the clumps in the experimental plots.

1942.

Number of dead culms counted and their age.					
Before A.	A.	B.	C.	D. etc.	Total

These records show that all culms survive almost without exception for about 5 to 6 years, after which they begin to die, *i.e.*, dry up. Culms of 1935 (A) had practically all disappeared by 1944 while very few of 1936 culms (B) were alive at the time of the last

recording (July 1944). The oldest culms on record are now (*i.e.*, 1945) 10 years old. From the third year onwards the side branches dry up progressively from below upwards, and the few (A) culms which are still alive have green leaves only in their upper-most side branches. A definite correlation seems to exist between the age of a culm and the length over which living side branches exist judged from the availability of assimilating leaves. A culm is most useful in the 2nd and 3rd years of its life when all the branches bear green leaves. The branches start dying from the 3rd or 4th year onwards progressively from below upwards and between the 8th and 10th year almost all branches will be dry except the topmost ones.

The following information has been recorded on the subject by P.N. Deogun :—

J.W. Nicholson estimated the average age of a culm at 7 years in his Sambalpur Working Plan of 1921 (Orissa). The average life of a culm in Javadi hills (Madras) is said to lie between 4 and 12 years. In Punjab it was found that very few of the culms lived up to 8 years, and that those which were 4 to 5 year old showed signs of deterioration, more so on the hotter aspect. In Uttar Pradesh, Lansdowne division, it was found that culms begin to die in their sixth season, and that they die in the next year or two so that the average life of a culm works out to about 7 years. Deogun sums up in the following words :— " Meanwhile the average life of a culm, growing in an average locality, without any maltreatment may be taken to be not more than 7 years. The average age of full maturity may be only 5 or 6 years."

Under the conditions obtaining normally in our bamboo forests where annual ground fires and uncontrolled fellings by license holders are a common feature, the average life of culms is 6 to 7 years, but individual culms in clumps protected from fire and maltreatment may last up to 10 years or more. A culm completes its growth by the end of the second growing season, when all the side branches are provided with their full foliage.

(ii) **The numerical relationship between the number of existing culms and the average annual production (number) of new culms.**

No such relation can be established, generally, and culm production seems to be largely independent of the existing number of culms.

The following tabular statements show the results obtained in the experimental plots.

(See P. 403-407)

(iii) **The numerical relationship between the number of culms which die during a year and the number of culms existing in a clump.**

No definite relationship can be established. The death of culms seems to depend upon various external and internal factors which require further study.

(iv) **Effect of felling intensities upon :**

(**1**) **number of new culms** (**2**) **condition of new culms classified under—**(*a*) **normal,** (*b*) **switchy and** (*c*) **under-developed.**

In the five experimental plots under study fellings of various intensities were conducted and the number of new culms produced each year and the condition of the new culms, classified under the three classes mentioned above, were recorded. The new culms were called '*normal*' if they are of average size, both as regards diameter and length, compared to the older culms in the same clump. '*Switchy*' culms are those which are thin, long and flexible (whippy) with generally reduced leaves crowded at the nodes, resembling, somewhat a " witches broom ". *Under-developed* culms are less than the average size *i.e.*, sub-normal in length and diameter, and are intermediate in condition between '*switchy*' and '*normal*' culms.

The following tables show the results. Beginning with 1935, the annual culms have been recorded under the headings A, B, C, etc. Those produced in 1935 being called A, those of 1936 being B, and so on up to those of 1943 which are called I.

Dendrocalamus strictus : *Numerical relationship between the existing Old Culms and the annual production of New Culms.*

Locality—Gangur. **EXPERIMENTAL PLOT I.** Forest Type Mixed - Dec. II/III.

Rainfall—About 30″.

Block No.	1935		1936		1937		1938		1939		1940		1941		1942		1943		Treatment.
	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms.	No. of clumps and culms existing.	No. of new culms	No. of clumps and culms existing.	No. of new culms.	
I.	19=422	36	19=458	54	19=0	34	8=34	6	4=29	24	4=41	22	4=61	10	3=55	10	4=0	10	clumps clearfelled (100%) in 1937 and again in 1942.
II.	17=270	12	17=282	30	17=82	77	15=152	102	15=239	105	15—330	102	15=420	67	15=470	50	15=131	64	75% clumps felled in 1937 and again in 1942.
III.	18=256	9	18=256	16	18=143	23	18=163	52	18=213	56	18=252	81	18=326	51	18=357	24	18=183	44	50% clumps felled in 1937 and again in 1942.
IV.	18=251	9	18=260	22	18=207	18	17=220	29	18=234	59	18=259	73	18=324	49	18=360	33	18=278	39	25% clumps felled in 1937 and again in 1942.
V.	17=231	14	17=245	25	17=270	25	17=290	31	17=290	48	17=313	66	17=366	56	17=396	32	17=393	44	clumps cleaned in 1937 and again in 1942. No green fellings done.

(In all cases dead culms have been eliminated from the account).

EXPERIMENTAL PLOT 2.

Locality—Gangur.

Rainfall—about 30"

Forest type—Mixed dec. II/III

Aspect—Slight North-West, cleyey loam with humus.

Block No.	1936		1937		1938		1939		1940		1941		1942		1943		Felling intensities
	Clumps = culms	B	Clumps = culms	C	Clumps = culms	D	Clumps = culms	E	Clumps = culms	F	Clumps = culms	G	Clumps = culms	H	Clumps = culms	I	
I	12=424	63	12=0(1)	32	4=32	44	5=62	29	5=74	19	6=91	28	16=109	28	6=121	34	100%
II	12=168	36	12=57(2)	35	12=75	75	12=142	59	12=183	27	12=204	39	12=239	17	12=228	48	75%
III	12=297	55	12=172(3)	56	12=222	74	12=287	77	12=349	60	12=400	70	12=469	37	12=462	77	50%
IV	15=950	118	15=795(4)	123	15=890	79	15=944	136	15=1018	151	15=1090	142	15=1149	72	15=1042	136	25%

(1) Clumps clearfelled (100% thinned).
(2) Clumps felled 3 in 4 (75% thinned).
(3) Clumps felled 1 in 2 (50% thinned).
(4) Clumps felled 1 in 4 (25% thinned).
(In all cases dead culms have been eliminated from the account).

EXPERIMENTAL PLOT 3.

Locality—Gangur. Forest type—Mixed-Dec. II/III.

	1937		1938		1939		1940		1941		1942		1943	
Thinning intensity	Clumps= culms.	C.	Clumps= culms.	D.	Clumps= culms.	E.	Clumps= culms.	F.	Clumps = culms.	G.	Clumps= culms.	H.	Clumps= culms.	I.
100%	33= 449	15	33= 0	2	6= 2	10	11= 12	20	11= 29	10	11= 39	8	6= 24	7
75%	43 = 871	60	43= 233	87	43= 316	435	43= 706	370	43=1025	245	43=1259	254	43=1440	161
50%	37= 706	59	37= 383	94	37= 468	290	37= 726	323	37=1014	175	37=1188	165	37=1294	128
25%	57= 768	24	57= 591	100	57= 672	302	57= 907	295	57=1115	197	57=1309	182	57=1353	132
0%	58= 731	56	58= 787	132	58= 887	180	57= 947	292	57=1123	181	57=1304	168	57=1342	160

(In all cases dead culms have been eliminated from the account).

EXPERIMENTAL PLOT NO. 4.

Locality : Aramballi

Forest type—Mixed Dec. II.

Block No.	1936		1937		1938		1939		1940		1941		1942		1943		
	Clumps =culms.	B.	Clumps =culms.	C.	Clumps =culms.	D.	Clumps =culms.	E.	Clumps =culms.	F.	Clumps =culms.	G.	Clumps =culms.	H.	Clumps =culms.	I.	Thinning intensity
1	20=293	32	20=195 (1)	26	20=217	63	20=243	63	20=247	112	20=337	69	18=397 (1)	41	18=300	70	33%
2	34=350	35	34=131 (2)	65	34=194	78	34=260	56	34=293	101	34=350	81	32=415 (2)	62	32=167	84	66%
3	28=218	37	28=255 (3)	17	28=260	49	28=284	26	28=262	80	28=291	70	27=345 (3)	48	27=393	66	0%

(1) Thinned—33% in the years 1937 and 1942.

(2) Thinned—66% in the years 1937 and 1942.

(3) Not thinned, but only dead culms removed.

(In all cases dead culms have been eliminated from the account).

(Continued)

EXPERIMENTAL PLOT 5.

Locality : Aramballi

Forest type—Mixed-Dec. II.

Block No.	1937		1938		1939		1940		1941		1942		1943		
	Clumps =culms.	C.	Clumps =culms.	D.	Clumps =culms.	E.	Clumps =culms.	F.	Clumps =culms.	G.	Clumps =culms.	H.	Clumps =culms.	I.	Thinning intensity
4	36=331	50	36=381 (1)	97	36=437	90	36=473	127	35=536	122	35=657 (2)	85	35=513	127	0%
5	28=273	32	28=199 (3)	72	28=262	109	28=330	133	28=423	123	28=544 (4)	86	27=305	175	33%
6	30=291	42	30=114 (5)	63	30=173	98	27=251	135	27=359	102	27=461 (6)	103	25=135	138	66%

(1) Thinned 0% in 1938 and (2) 25% in 1942.

(3) Thinned 33% in 1938 and (4) 50% in 1942.

(5) Thinned 66% in 1938 and (6) 75% in 1942.

(In all cases dead culms have been eliminated from the account).

Dendrocalamus strictus: Effect of felling intensities on the number and condition of new culms

Exp. Plot. No. 1.

Rainfall 30 inches.

Block No.	No. of clumps on record.	No. of old culms.	No. and condition of new culms.				Remarks.
			Normal	Switchy.	Under-developed.	Total	
			1935 — A. (**Before felling**)				
1.	19	422	36	..	..	36	
2.	17	240	12	..	..	12	
3.	18	256	9	..	..	9	
4.	18	251	9	..	..	9	
5.	17	231	14	..	..	14	
			1936 — B.				
1.	19	458	54	..	..	54	
2.	17	252	30	..	..	30	
3.	18	265	16	..	..	16	
4.	18	260	22	..	..	22	
5.	17	245	25	..	..	25	
			1937 — C. (**Year of felling**)				
1.	19	0	00	34	00	34	
2.	17	82	42	35	..	77	
3.	18	143	18	0	5	23	
4.	18	207	17	0	0	17	
5.	17	270	24	0	1	25	
			1938 — D. (**After felling**)				
1.	8	34	0	6	0	6	
2.	15	152	60	11	31	102	
3.	18	163	44	0	8	52	
4.	17	220	29	0	0	29	
5.	17	290	27	0	4	31	

Block No.	No. of clumps living.	No. of old culms.	No. of new culms and their condition.				Remarks
			Normal	Switchy.	Under-developed.	Total	
			1939 — E.				
1.	4	29	19	5	24	53	
2.	15	239	44	26	35	105	
3.	18	213	36	5	15	56	
4.	18	234	34	13	12	59	
5.	17	290	45	1	2	48	
			1940 — F.				
1.	4	41	3	3	16	22	
2.	15	330	77	4	21	102	
3.	18	252	71	1	9	81	
4.	18	259	66	0	7	73	
5.	17	313	56	0	10	66	
			1941 — G.				
1.	4	61	10	0	0	10	
2.	15	420	66	%	0	67	
3.	18	326	51	0	0	51	
4.	18	324	44	5	0	49	
5.	17	366	55	%	0	56	
			1942 — H.				
1.	4	71	10	0	0	10	
2.	15	470	50	0	0	50	
3.	18	357	24	0	0	24	
4.	18	260	33	0	0	33	
5.	17	396	32	0	0	32	
			1943 — I.				
1.	4	0	0	10	0	10	
2.	15	131	30	0	34	64	
3.	18	183	35	3	6	44	
4.	18	278	31	5	3	39	
5.	17	393	30	10	4	44	

Treatment.

Block 1. All clumps clearfelled in 1937 and again in 1942.

Block 2. In all clumps 75% of culms thinned in 1937 and again in 1942.

Block 3. In all clumps 50% of culms thinned in 1937 and again in 1942.

Block 4. In all clumps 25% of culms thinned in 1937 and again in 1942.

EXPERIMENTAL PLOT 2.

Rainfall 30 inches.

Dry Zone—Gangur.

Block No.	No. of clumps living.	No. of old culms.	No. of new culms and their condition.				Remarks.
			Normal	Switchy.	Under-developed.	Total	
			1936 — B.				
1.	12	424	63	..	..	63	Clearfelled.
2.	12	168	36	..	..	36	75% felled.
3.	12	297	55	..	..	55	50% felled.
4.	15	950	118	..	..	118	25% felled.
			1937 — C.				
1.	12	0	9	15	8	32	Clearfelled.
2.	12	57	22	13	..	35	75% felled.
3.	12	172	38	13	5	56	50% felled.
4.	15	795	123	..	..	123	25% felled.
			1938 — D.				
1.	8	32	..	40	4	44	4 Clumps dead
2.	12	75	58	11	6	75	..
3.	12	222	70	1	3	74	..
4.	15	890	79	..	..	79	..
			1939 — E.				
1.	5	62	..	19	10	29	3 clumps dead.
2.	12	142	16	18	25	59	..
3.	12	287	47	18	12	77	..
4.	15	944	122	13	1	136	..
			1940 — F.				
1.	5	74	3	2	14	19	..
2.	12	183	24	1	2	27	..
3.	12	349	53	..	7	60	..
4.	15	1018	141	..	10	151	..
			1941 — G.				
1.	6	91	22	3	3	28	
2.	12	204	39	..	..	39	
3.	12	400	70	..	..	70	
4.	15	1090	142	..	..	142	

EXPERIMENTAL PLOT 3.

(Dry Zone—Gangur)

Block No.	No. of clumps on record.	No. of old culms.	No. of new culms and their condition.				Remarks.
			Normal	Switchy.	Under-developed.	Total	
			1937 — C.				
1.	33	449	15	..	..	15	
2.	43	871	60	..	..	60	
3.	37	706	59	..	..	59	
4.	57	768	24	..	..	24	
5.	58	731	56	..	..	56	
			1938 — D.				
1.	33	0	..	2	..	2	Clear-felled during the year.
2.	43	233	15	27	45	87	75% felled.
3.	37	383	88	6	..	94	50% felled.
4.	57	591	97	..	3	100	25% felled.
5.	58	787	132	..	..	132	No green fellings.
			1939 — D.				
1.	6	2	..	7	3	10	
2.	43	316	67	103	265	435	
3.	37	468	161	25	104	290	
4.	57	672	249	16	37	302	
5.	58	887	79	17	84	180	
			1940 — F.				
1.	11	12	..	17	3	20	
2.	43	706	347	3	20	370	
3.	37	726	315	7	1	323	
4.	57	907	293	1	1	295	
5.	57	947	285	5	2	292	
			1941 — G.				
1.	11	29	7	..	3	10	
2.	43	1025	245	..	..	245	
3.	37	1014	174	1	..	175	
4.	57	1115	195	2	..	197	
5.	57	1123	180	1	..	181	

Block No.	No. of clumps living.	No. of old culms.	No. of new culms and their condition.				Remarks
			Normal	Switchy.	Under-developed.	Total	
			1942 — H.				
1.	11	39	0	8	0	8	
2.	43	1259	254	0	0	254	
3.	37	1188	165	0	0	165	
4.	57	1309	182	0	0	182	
5.	57	1304	168	0	0	168	
			1943 — I.				
1.	6	24	0	7	..	7	
2.	43	1440	143	8	10	161	
3.	37	1294	112	6	10	128	
4.	57	1353	132	0	0	132	
5.	57	1342	154	3	3	160	
			1936 — B.				
1.	20	293	32	..	..	32	33% felled.
2.	34	350	35	..	..	35	66% felled.
3.	28	218	37	..	..	35	No green fellings.
			1937 — C.				
1.	20	195	23	..	3	26	33% felled.
2.	34	131	32	4	29	65	66% felled.
3.	28	255	16	..	1	17	No green fellings.
			1938 — D.				
1.	20	217	60	..	3	63	
2.	24	194	75	..	3	78	
3.	28	260	49	..	..	49	
			1939 — E.				
1.	20	243	22	27	14	63	
2.	34	260	32	9	15	56	
3.	28	284	16	4	6	26	
			1940 — F.				
1.	20	247	93	5	14	112	
2.	34	293	89	4	8	101	
3.	28	262	69	8	3	80	

Block No.	No. of clumps living.	No. of old culms.	No. of new culms and their condition. Normal	Switchy.	Under-developed.	Total	Remarks.
			1941 — G.				
1.	20	337	69	..	1	70	
2.	34	350	76	4	1	81	
3.	28	291	67	2	1	70	
			1942 — H.				
1.	18	397	41	0	0	41	
2.	32	415	62	0	0	62	
3.	27	345	48	0	0	48	
			1943 — I.				
1.	18	300	68	1	1	70	
2.	32	167	83	0	1	84	
3.	27	393	61	5	0	66	

EXPERIMENTAL PLOT 5.

Wet Zone——Arambally.

Rainfall 65 inches.

			1937 — D.				
4.	36	331	50	0	0	50	
5.	28	273	32	0	0	32	
6.	30	291	42	0	0	42	
			1938 — D.				
4.	36	381	86	0	11	97	No green fellings.
5.	28	199	67	0	5	72	33% felled.
6.	30	114	60	0	3	63	66% felled.
			1939 — E.				
4.	36	437	43	24	23	90	
5.	28	262	87	18	4	109	
6.	30	173	72	25	1	98	

Block No.	No. of clumps living.	No. of old culms.	No. of new culms and their condition.				Remarks
			Normal	Switchy.	Under-developed	Total	
			1940 — F.				
4.	36	473	117	6	4	127	
5.	28	330	133	0	0	133	
6.	27	251	128	0	7	135	
			1941 — G.				
4.	35	536	120	0	2	122	
5.	28	423	121	2	0	123	
6.	27	359	91	2	9	102	
			1942 — H.				
4.	35	657	85	0	0	85	
5.	28	544	86	0	0	86	
6.	27	461	103	0	0	103	
			1943 — I.				
4.	35	513	114	1	12	127	
5.	27	305	162	0	13	175	
6.	25	135	134	0	4	138	

The fellings were made uniformly over the clumps, the youngest and younger ones and those supporting the youngest ones being spared during the cutting, as far as practicable.

The following general conclusions can be drawn from the above figures although further data are required to confirm the results :—

(1) Clear-felling of culmps with or without clear-felling the over-head forest trees results in the death of a high percentage of clumps in the dry zone (rainfall 30") and those that survive produce switchy or under-developed culms for three to four years or more and may eventually die off. Should they continue to live, they will be still unfit for a second cutting for at least 5 years.

The recorded opinions on the subject quoted below are copied from P.N. Deogun's I.F.R. on the subject.

" If all the shoots be cut down the stock will be impoverished and ultimately die off....". (Kurz).

" The shoots should not all be cut every year for if this was done the root stock would die....". (Parish).

" It is pretty well known that bamboo clumps if entirely cut down yield for several years but small shoots and not infrequently die." (King).

The clumps do not, however, necessarily always die after clear-felling, the height of cutting being an important factor in deciding their survival. In Experimental Plot 2, for example, among clumps in which the culms

were cut at waist-height and knee-height, (2 to 4 feet high) six out of the twelve clumps survived the clearfelling (done in June 1937) and one of these clumps started producing "normal" shoots from 1938 onwards *i.e.*, in the very first year—following the clear-felling. If the fellings are made at the height of summer, long before the growing season starts, and the culms are felled flush with the ground the percentage of surviving clumps is low and the new culms produced will be all switchy or slender the leaves being small in size and often inadequately silicified (Experimental Plot I). If the fellings be made at the height of summer, and that after removing the tree shade over the bamboo crop, the results are still more harmful to the bamboo as seen in Experimental Plot 3, where only 6 out of 33 clumps survived and these had only 24 shoots in all, as against Experimental Plot 2 where 4 out of 19 clumps, with 71 shoots in all, survived.

(2) In the dry zone (rainfall 30″) a 75 per cent thinning results in the production of a large number of switchy and under-developed shoots for at least two seasons after the felling. For this again, the time of felling in the year and the felling heights are important factors; if the felling be done just at the beginning of the rainy season (growing season) the culms of that year will be almost entirely normal (Experimental Plot 3, culms of 1937,—C.). If, on the other hand, the felling is done long before the rainy season, at the height of summer, a good number of the new culms produced will be switchy.

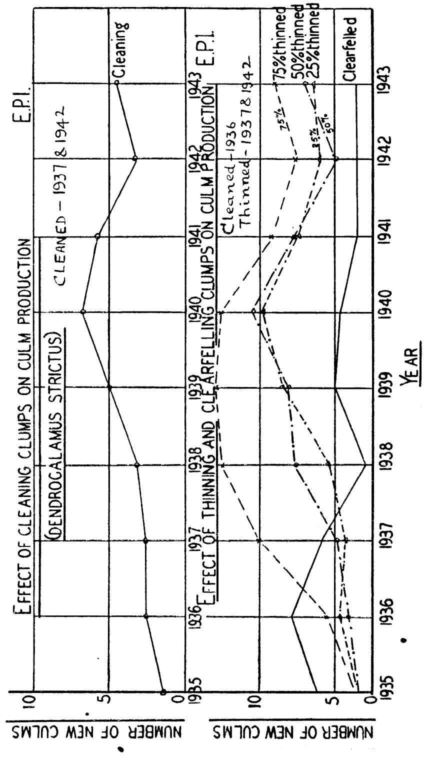
(3) In the wet zone (rainfall 65″) 66 per cent thinning (removal of 2 for every 3 culms) may result in the production of under-developed shoots in the season after this operation. In Experimental Plot 4 nearly one half the number of new culms (C. culms) were under-developed in 1937. This did not, however, happen in the case of Experimental Plot 5 where the overhead shade had been removed under the same intensity of thinning.

(4) In the dry zone (rainfall 30″) a 50 per cent thinning resulted in producing a small number of under-developed and/or switchy shoots in the year after the felling. In Experimental Plot 3, however, where the overhead forest shade had been removed, the proportion of switchy shoots to the normal ones was much smaller compared to those in Experimental Plots 1 and 2.

(5) In the wet zone (rainfall 65″) as well as in the dry zone (rainfall 30″) thinnings of the intensities of 33% and 25% respectively produced no change in the quality of the new culms *i.e.*, all the new culms were *normal*.

The results could be summed up in the following words:—

Clearcutting, flush with the ground, of all culms, is very harmful and may kill the rhizome outright or leave it crippled for a number of years thereafter. Thinning of the intensities of 66 per cent or more in the wet zone and 50 per cent or more in the dry zone results in the deterioration of the quality and size of the new culms, and the harmful effects may last up to the third year after the felling in the case of the 75% thinning intensity. Thinning of 25% intensity in the dry zone and 33% in the wet zone produces no harmful effect on the size and condition of new culms. Repetition of clearfelling kills the clump in most cases (Experimental Plot 1). The 75% felled clumps produce new culms of maximum number but minimum quality whether with or without, overhead forest shade.


EFFECT OF CLEANING CLUMPS ON CULM PRODUCTION
(DENDROCALAMUS STRICTUS)
E.P.I.
CLEANED - 1937 & 1942
Cleaning
NUMBER OF NEW CULMS
10
5
0
EFFECT OF THINNING AND CLEARFELLING CLUMPS ON CULM PRODUCTION
E.P.I.
Cleaned - 1936
Thinned - 1937 & 1942
75% thinned
50% thinned
25% thinned
75%
25%
50%
Clearfelled
NUMBER OF NEW CULMS
10
5
0
1935
1936
1937
1938
1939
1940
1941
1942
1943
YEAR

V. The most suitable felling cycle for Dendrocalamus strictus under local conditions.

In deciding the above a clump has been considered fit for a second felling when *it has regained the same number of Normal Culms as existed at the time of the first felling.*

The following statistics are available :—

E.P. No.	No. of culms at the time of thinning.	Year.	Thinning intensity.	Year in which the clumps regained this number.	No. of seasons taken to reach normal	Rainfall	Remarks.
IV.	293	1937	33%	1940	3	65″	Over-head tree cover not cut.
IV.	385	1937	66%	1941	4	-do-	
V.	305	1938	33%	1940	2	-do-	Over-head shade removed by girdling the trees.
V.	333	1938	66%	1941	3	-do-	
I.	282	1937	75%	1941	5	30″	Over-head tree cover not cut.
I.	281	1937	50%	1940	4	-do-	-do-
I.	282	1937	25%	1939	3	-do-	-do-
II.	168	1937	75%	1940	4	-do-	-do-
II.	297	1937	50%	1939	3	-do-	-do-
II.	950	1937	25%	1938	2	-do-	-do-
III.	871	1938	75%	1941	4	-do-	Overhead shade removed.
III.	706	1938	50%	1940	3	-do-	-do-
III.	768	1938	25%	1939	2	-do-	-do-

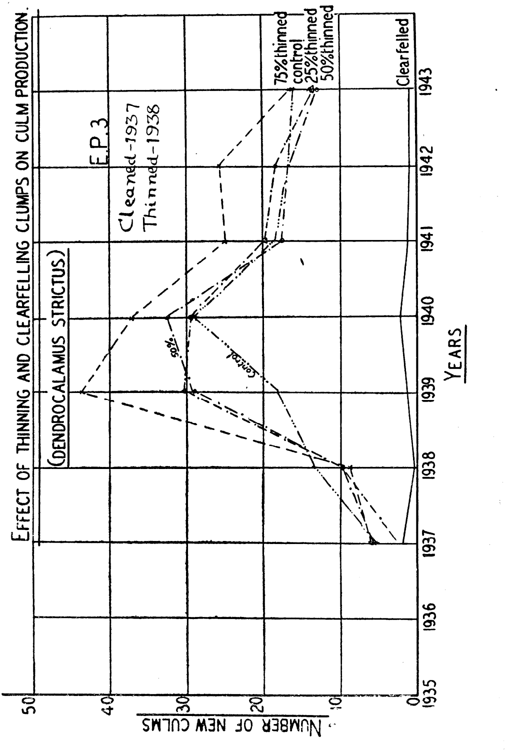
The results show that in a dry locality (30″ rainfall) with a heavy thinning resulting in the removal of 75% or 3 in every 4 culms (the oldest ones and those that are dying cut on a thinning principle) a felling cycle of 4 to 5 years is indicated ; with a moderate heavy thinning resulting in the removal of 50% or 2 in every 4 culms a felling cycle of 3 to 4 years is indicated, while with a light thinning of 25% the felling cycle indicated is 2 to 3 years. In a wet locality like Arambally a felling cycle of 3 to 4 years is indicated with a heavy thinning (66%) in which 2 for every 3 culms are removed and a cycle of 2 to 3 year is indicated with a moderate thinning (33%) resulting in the removal of 1 in every 3 culms.

A shorter cycle is indicated for forest where three is no overhead tree cover than for one where there is moderate tree cover (20 to 30 trees per acre.)

(vi) **The most advantageous felling height under local conditions.**

In E.P. 2 near Gangur (dry locality with 30″ rainfall) fellings were conducted with different felling heights, some clumps being cut at breast-height (4½ feet), some at knee-height (2½ feet) and some flush with the ground, under 4 intensities of felling *viz.*, clearfelling, 75% thinning, 50% thinning and 25% thinning. Among the clumps clearfelled, those cut at breast-height all survived, those cut at knee-height struggled for some time and nearly all died, while those cut flush with *the ground level showed no signs of life after* the felling and died soon after. High cutting, *i.e.*, cutting at breast height, resulted in the case of one year old culms in the production of long whippy branches *which intertwine with other culms and cause difficulties in the proper working of a clump thus giving rise to congestion of clump.*

In case the culms are cut before their side branches have been formed *i.e.*, before the second growing season is completed, the side branches which emerge are stronger, being


EFFECT OF THINNING AND CLEARFELLING CLUMPS ON CULM PRODUCTION.
(DENDROCALAMUS STRICTUS)
E.P. 3
Cleaned-1937
Thinned-1938
75% thinned
control
25% thinned
50% thinned
Clearfelled
50%
Control
NUMBER OF NEW CULMS
0
10
20
30
40
50
1935
1936
1937
1938
1939
1940
1941
1942
1943
YEARS

much thicker than in normal culms and grow more or less *upward* (erect) *i.e.*, are strongly apogeotropic, and not horizontal like normal side-branches. If the culm be cut at the end of the second growing season when the side branches have been fully formed, thin long branchlets emerge on the cut culm on both sides of the insertion in the upper whorl or whorls of branches forming more or less a cluster. When a culm more than 2 years old is cut it does not normally develop any more branches but dries up gradually. This will, however, vary with the season of cutting. Culms 3 or even 4 years old cut high just at the beginning of the growing season sometimes give off new, thin and long branchlets at the base of the old side-branches *i.e.*, where they are seated on the old culms. This was seen in E.P. 2 during the rainy season of 1944, when culms of 1940 (F) and 1941 (G) cut in the beginning of June at chest height developed new branchlets at the base of the old side branches. It was also found that bits of mature culms (2 years old) with one complete node, cut at the end of June and left in contact with the ground under the forest shade, started sprouting and developing new side-branches and pushing out new leaves. This observation, however, requires further confirmation by experiment.

(vii) **Influence of overhead forest cover on the growth of the bamboo.**

As regards overhead shade, the natural bamboo forests have, as a rule, a varying overwood of deciduods species, the vigour of the bamboos varying with the density of the overwood and *vice versa*. M.D. Chaturvedi (Bulletin No. 1 of the U.P. forest department), as a result of experiments in Lansdowne Division, has concluded that *Dendrocalamus strictus* shows better growth under light shade and in the open and that heavy shade is undesirable, specially on sheltered, cool aspects. J. M. Sen Gupta has confirmed this opinion and added that most species of bamboo are light demanders and although high shade is not harmful low shade is definitely so. H.G. Champion (*vide* J. M. Sen Gupta, proceedings of the V Silvicultural Conference) has opined that appreciable overhead canopy is usually deterimental to bamboo development, and that it is justifiable to keep the canopy open in areas where the potential value of bamboo production exceeds that of the trees forming the canopy. Experiments were carried out at Nauri with the object of ascertaining different canopy variations distingusihed as *light high*, *light low*, *heavy high* or *heavy low*. According to the prescriptions here, if the overwood alter appreciably in type it should be adjusted the original class ; obviously this is difficult in practice (J. N. Sen Gupta) owing to want of any clear definition of the terms *light high*, *light low* etc.

Two experimental plots were laid out for the purpose of determining the influence of overhead forest cover E.P. 3. and E.P. 4., one in the relatively dry zone at Gangur with 30″ rainfall and the another in the moist zone—with 65″ rainfall. Plots 1 and 3 were comparable as regards overhead cover ; in E.P. 1 the overhead cover was not disturbed but in E.P. 3 all trees were effectively girdled to obtain full overhead light. So also plots 4 and 5 were comparable, and the overhead cover remained intact in 4 ; it was removed by girdling all over-head trees in 5.

The following results were noticed :—

The removal of overhead cover increased *to a certain extent* the production of new culms both in quantity and quality. *The largest number of new bamboos were produced in the plot without overhead cover. The new culms also emerged earlier in the season, looked more vigorous and grew more rapidly at first.* The removal of overhead cover has, therefore, similar effect on the bamboo clumps as it has on the growth of coppice shoots in a coppice forest.

The average production of culms per clump is given in the following statement.

Dry zone—Gangur.

Average number of culms produced per clump.

	1938	1939	1940	1941	1942	1943	Remarks.
E. P. I. (Overhead cover not removed).	..	7.0	6.8	4.5	3.3	4.3	75% felled.
E.P. 3. (Overhead cover removed).	..	10.1	8.6	5.7	5.9	3.9	do.
E.P. 1. (Overhead cover not removed).	..	3.1	4.5	2.9	1.3	2.4	50% felled.
E.P. 3. (Overhead cover removed).	..	7.9	8.7	4.7	4.4	3.4	do.
E.P. 1. (Overhead cover not removed).	..	3.3	4.0	2.7	1.8	2.1	25% felled.
E.P. 3. (Overhead cover removed).	..	5.3	5.1	3.4	3.2	2.3	
E.P. 1. (Overhead cover not removed).	1.8	2.8	3.9	3.3	1.9	2.6	Only cleaning done ; no green felling.
E.P. 3. (Overhead cover removed).	2.3	3.1	5.1	3.2	2.9	2.8	do.

Wet zone—Arambally.

	1938	1939	1940	1941	1942	1943	Remarks.
E.P. 4. (Overhead cover not removed).	..	3.1	5.6	3.4	2.3	3.9	33% felled.
E.P. 5. (Overhead cover removed).	..	3.9	4.7	4.4	3.0	6.4	do.
E.P. 4. (Overhead cover not removed).	..	1.6	3.0	3.4	2.0	2.6	66% felled.
E.P. 5. (Overhead cover removed).	..	3.2	5.0	3.8	3.8	5.5	do.
E.P. 4. (Overhead cover not removed).	1.7	0.57	2.8	2.5	1.8	2.4	Only cleaning done; no green felling.
E.P. 5. (Overhead cover removed).	2.7	2.5	3.5	3.5	2.4	3.6	do.

Overhead shade was left intact in E.P.s. 1 and 4, but the same was completely removed in E.Ps. 3 and 5.

The production of an increased number of culms, both in number and quality, has a direct bearing on the felling cycle, as already indicated in a preceding paragraph.

A forest without overhead cover could probably be worked on a shorter felling cycle as it is able to recover from the effect of felling in shorter time.

The following figures indicate the above statement more clearly.

E.P. No.	Thinning intensity	No. of seasons taken to regain original condition	Felling cycle indicated	Remarks.
1	2	3	4	5
		Wet zone——Arambally.		
IV.	33%	3	4 years.	Overhead shade intact.
V.	33%	2	3 years.	Overhead shade removed
IV.	66%	4	5 years.	Overhead shade intact.
V.	66%	3	4 years	Overhead shade removed
		Dry zone—Gangur.		
I.	25%	3	4 years	Overhead shade intact.
II.*	25%	2	3 years	Overhead shade intact.
III.	25%	2	3 years	Overhead shade removed
I.	50%	4	5 years	Overhead shade intact
II.*	50%	3	4 years	Overhead shade intact.
III.	50%	3	4 years	Overhead shade removed.
I.	75%	5	6 years	Overhead shade intact.
II.	75%	4	5 years	Overhead shade intact.
III.	75%	4	5 years	Overhead shade removed.

Plots IV and V and Plots I and III are more or less strictly comparable.

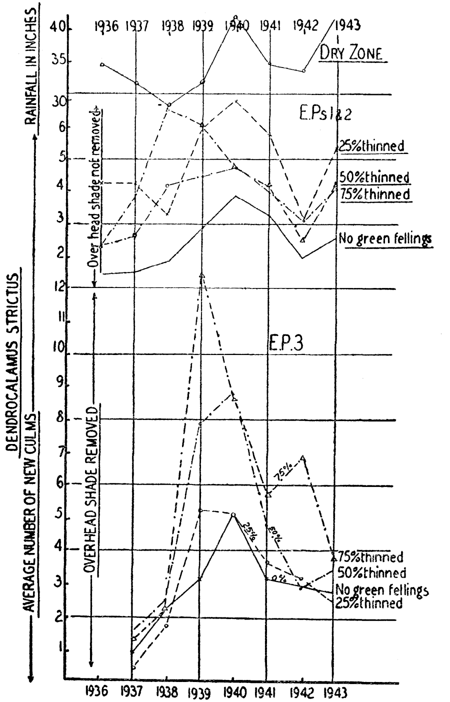
* Plot II is not comparable with I and III as it lies in a better locality adjoining a stream.

The results indicate therefore that in a bamboo forest on *the removal on the overhead tree cover we could probably also shorten the felling cycle* within reasonable limits. It is also probably advantageous, in forests set apart and worked entirely for bamboo, to keep the overhead cover open.

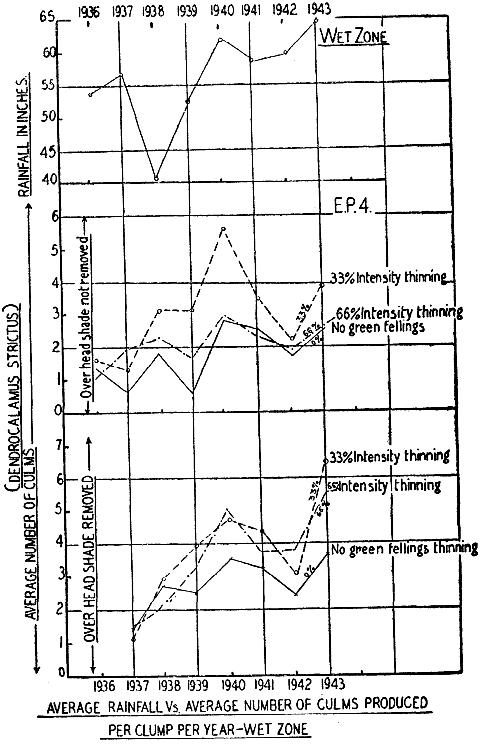
Influence of annual rainfall on culm production—The accompanying graphs (p. 422 and 423) indicate the results obtained in the experimental plots under different treatments :—

From the graphs it is seen that *whereas no direct correlation can be established between rainfall and culm production, years of plentiful rainfall produce generally a larger number of culms than those with deficient or scanty rainfall.* Among the years recorded, there are also none of markedly deficient rainfall except 1938. In the above graphs the effect of various treatments—intensities of thinning—have masked the influence of rainfall, if any, on culm production and it is therefore difficult to draw definite conclusions.

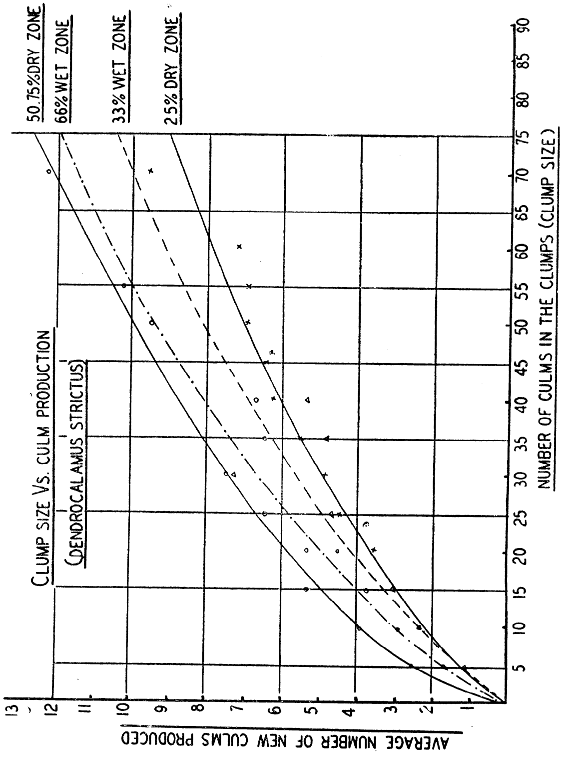
The above graphs also show the influence of varying intensities of thinning on the production of new culms. The largest number has been produced in the dry zone under the 75% felling intensity among the clumps enjoying full overhead light and in the years following the thinning; and this number immediately



AVERAGE RAINFALL Vs. AVERAGE NUMBER OF CULMS PRODUCED PER CLUMP PER YEAR—DRY ZONE



AVERAGE RAINFALL Vs. AVERAGE NUMBER OF CULMS PRODUCED PER CLUMP PER YEAR—WET ZONE


CLUMP SIZE Vs. CULM PRODUCTION
(DENDROCALAMUS STRICTUS)
50.75% DRY ZONE
66% WET ZONE
33% WET ZONE
25% DRY ZONE
NUMBER OF CULMS IN THE CLUMPS (CLUMP SIZE)
AVERAGE NUMBER OF NEW CULMS PRODUCED
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
1 2 3 4 5 6 7 8 9 10 11 12 13

gradually falls in the succeeding years. The production is less under the 50% and still less under the 25% felling intensity. It is comparatively less in the case of clumps which do not enjoy full overhead light under all intensities of thinning although relatively the largest number is produced under the 75% thinning intensity here also.

It is also found that mere cleaning of clumps, by which is understood the cutting away of all the existing dry culms from the clumps, results in an increased production of culms in the years following this treatment, and this again is greater in the clumps enjoying full overhead light than in those which are placed under the natural forest cover.

Relationship between clump size and culm production :—

The following graphs (see p. 425) indicate the tentative conclusions recorded below :—

IT WILL BE SEEN FROM THE GRAPHS THAT, WITH INCREASING SIZE OF CLUMP, UP TO A CERTAIN UPPER SIZE LIMIT, THE PRODUCTION OF NEW CULMS ALSO INCREASES: FOR THE SAME CLUMP SIZE, A HEAVIER THINNING UP TO A CERTAIN LIMIT, RESULTS IN GREATER PRODUCTION OF NEW CULMS.

II **Subsidiary investigations.**

(i) **Effect of burning.**

According to J.M. Sen Gupta, the experimental plot at Nauri, Lansdowne division, U.P., already referred to, has for its object to ascertain the effect of burning bamboo areas on the yield in quality and quantity with fellings in different fellings cycles of 4, 5 and 6 years. 3 sub-plots are burnt under control (while 3 others fire-protected) annually at the beginning of the hot weather except for two successive hot weather after felling. In one of the Mysore experimental plots, also, accidental ground fires occurred in two consecutive years in one of the blocks, while its neighbouring one remained free from it. It was found, as a result thereof, that in the burnt plot the new culms appeared *earlier* in the season (by about 10 days) and were also *more numerous* :—

(ii) **Effect of cleaning clumps on the production of new culms.**

By *cleaning* is understood in Mysore the removal of all dead culms from the clumps. To study the result of this operation a cleaning each was carried out in E.P. I, in the years 1937 and 1942, and in block V of E.P. 3 one cleaning was done in 1938.

THERE WAS INCREASED CULM PRODUCTION AFTER EACH CLEANING, FOR TWO OR MORE YEARS SUCCEEDING THIS OPERATION

It has to be emphasized that the threads of conclusion drawn in the foregoing paragraphs are not directly applicable to bamboo forests all over India, not can it be asserted that, under similar treatments, the same results can be expected even under climatic and edaphic conditions which are not appreciably different from those mentioned above. Bamboos in general and *Dendrocalamus strictus* in particular have very wide distribution in India, the latter extending almost from the tip of the Deccan tableland to the Sub-Himalayan zone but this does not necessarily mean that the response of this bamboo to the different kinds of treatment detailed in the forgoing paragraphs will be the same all over this vast territory. Though apparently quite hardy, *Dendrocalamus strictus* is one of those species which is very sensitive in its response to variations of climatic and adaphic factors, even if they are slight; one of the most important among them is the availability of moisture in the growing season and, the response of the bamboo to this particular factor is so subtle that even small variations in the distribution of rainfall in one and the same locality can produce markedly varying results on the number of culms produced in one and the same clump in different years. The general results of such experiments on bamboos have therefore to be accepted with great caution, and the conclusions drawn in one locality should not be taken as final for deciding the method of management in another, unless confirmed by actual experiment in the concerned locality.

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WOOD PRODUCTS*

By Dr. M.N. Ramaswamy

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1. Wood products are many in number and diverse in nature. A world authority has listed more than 4,000 distinct uses of wood. Right from his cradle to his coffin, from walking sticks to aeroplanes, for a toothpick or a ship beam, for his food, drink, clothes and shelter, man is dependent on wood. It is doubtful if any other raw material in nature has such wide and varied uses. I can attempt to present to you within the time allotted to me no more than a birds-eye view of this vast domain of wood products and pick out for your special notice the more prominent features of a fascinating landscape.

2. Let me briefly recount the more significant properties of wood. Chemically, wood substance is composed principally of cellulose and lignin with very much smaller proportions of other complex chemical entities like pectins, pantosans, tans, colouring matter, essential oils and the like. Chemically, different species of wood are all about alike being built up of cellulose and lignin which can be likened to bricks of construction. The pattern in which these bricks are used to build up wood tissue varies, however, from species to species. For, wood is cellular in structure, being made up of a very large number of tiny cells cemented together much in the fashion of a honey comb. It is this micropattern that is characteristic of the individual species and is used to identify the species—much in the same way as finger prints are used to identify human beings. And, it is this structure of wood, chemically all woods being almost alike but physically each species being unique, that determines its other characterstic properties.

3. Wood is light in weight; and, weight for weight and in directions parallel to its grain, wood is actually stronger than steel. Its coefficient of thermal expansion is low. It is a poor conductor of heat and electricity. It insulates sound. It is kind to tools and can be machined and polished to give smooth surfaces. It has an individuality in its beauty—no two species of wood are alike and no two pieces of the same wood are exactly similar. It is this unusual combination of basic properties that makes wood a versatile material.

4. The earliest use of wood was probably as fuel. Coal and oil and electricity have largely shifted the emphasis from wood as industrial fuel but in regions where these latter are scarce, as for example in parts of South India, wood fuel is of some importance. Even for the domestic hearth, a blazing log fire radiates a cheerful friendly warmth which no other heating can quite replace. The calorific values of drywood is of the order of 8,000. The controlled oxidation of wood yields charcoal. Hardwoods yield about 20 per cent of their weight in charcoal. And, the calorific value of charcoal is nearly double that of wood. This reduction in weight coupled with the increase in calorific value reduces significantly the transport costs of charcoal compared to the wood it is derived from. Charcoal assumed a new significance as Motor fuel during the war years. Apart from its use as fuel, charcoal is used as a chemical raw material in the manufacture of producer Gas, Water Gas and as a reducing agent in metallurgy. Further, Charcoal can be activated by suitable treatment. Active charcoal is a good absorbent and is widely used to remove unwanted impurities in many manufacturing processes, in gas masks and in sanitary practice.

5. We may now pass on to wood as a material of construction. The very word timber tells a tale, being derived from Latin roots meaning, to build, to house. Man's earliest houses—apart from natural shelter like caves—were probably of wood. And, even today, it is reckoned that more than 80 per cent of all the houses in so progressive a country as the United States of America are built of wood. In our own houses, wood is a very important component. Wood for bridges and foundations, for ships and Railways (both for carriages and for sleepers on the track) for scaffolding and packing cases, wood for pit props and transmission poles are so common as to be taken for granted. The invention of timber connectors—a device for jointing and distributing the load at the meeting point of timber members—has greatly extended the field of wood as a material of construction. Clear Arches 350 feet wide have been built of timber using this new technique. In furniture and panelling and, in general, for interior trim and decoration

*Talk Broadcast from All-India Radio, Mysore, on 26-10-1950

where appearance and aesthetics are as important as mere utility, wood is supreme.

6. The technique of wood preservation has enabled us to extend the economic life of wood structures. Like other organic material, wood is susceptible to decay by attacks from lowly plant forms known as fungi and by insects. Wood can be adequately protected against these organisms by injecting into its porous structure under pressure suitable chemicals like creosote, compounds of arsenic, copper, chromium, boron, zinc, fluorine, phenols and the like. Attempts have also been made to inject into the living trees preservatives taking advantage of the natural circulation of sap. Each of these methods offers its own special advantages. Suffice it to say that creosoted wood in exposed weather beaten conditions, has given satisfactory service for 20, 30 and even for 40 years, in fact longer than the economic life of the structure itself. No more could be asked of any material of construction. For, there seems to be no purpose, shall I say, in designing a tooth brush which out lasts one's teeth. Similarly, there is no point in having just one component material in a construction to out last the construction itself.

7. Such uses of wood along with its utility for more particular purposes like matches, pencils and toolhandles represent what we might now call the traditional uses of wood. The limiting factors in its many uses so far were the facts that man could cut shorter pieces out of a log, but not make it longer; he could take thinner pieces out of a plank but not make it thicker. And no wood plank could be wider than the tree from which it was fashioned.

8. The invention of Plywood and its nearer relatives, Compreg and Impreg, have very largely overcome these inherent limitations of wood. Plywood is made of thin veneers of wood glued and pressed together, the individual plies being so placed that the grain of each sheet is at right angle to the grain of the sheet above and below it. An analogous product, Compreg, is made by impregnating wood with synthetic resins and then "Curing" the impregnated sheets under heat and pressure. The resulting product has the appearance of wood but is heavier, harder, with greater resistance to moisture, shrinkage and swelling. A slightly different technique is to mix wood waste with binding resins and press them into smooth hard boards of the requisite dimensions. The glues and resins used to bind and bond the wood in these processes have been developed to a stage where the joint and bonding is waterproof and actually stronger than the material which it binds. Another very recent advance to make wood pliable is by soaking it in hot aqueous solutions of urea and its derivatives. After such treatment, wood can be bent into any desired shape.

9. These technical developments have largely neutralised the inherent limitations of natural wood in respect of its size, weight, strength and its heterogenity. In fact, wood to-day is a tailored product made to measure to the customer's specifications. We can now practically do any thing with wood except draw it into a wire. And who can say man will not do it some day? These revolutionary developments in the technique of wood utilisation have further extended the uses of wood to a bewildering range. Even keels of ships which must take heavy punishment in the form of great strains in corrosive salt water, are made of laminated wood. The famous Mosquito—one of the fastest airplanes of its class during the last war—was an all-wood plane.

10. I now pass on *from* things made of wood to things made *from* wood—the use of wood as raw material for chemical processing. The earliest such process was probably the dry distillation of wood to yield methyl alcohol, acetone, acetic bodies, wood tar and charcoal. It is practiced even to-day. We are all familiar with paper and newsprint. Then came the cellulose products—rayon, transparent paper, raw film, explosives, celluloid, plastics and literally a host of other derivative. In fact, the modern era in cellulose chemistry is not unlike the hectic and extraordinarily fruitful research that found in coal tar a veritable Alladin's lamp for chemical products, earlier in the century.

11. Even more was yet to come. There is magic in cellulose. Early in the 1930's Bergius in Germany succeeded in hydrolysing wood to sugar. We can as yet but dimly visualise the end of the highway blazed out by this new wood product. For, this wood sugar could either be directly fermented to alcohol to give fuel for power and form the starting point for the manufacturing of a large number of chemicals, or, alternately, provide feedstuffs to livestock which in turn are valuable sources of fat and protein food to man. Thus, wood which first provided man with shelter and then with cloth is now made to yield both food and drink. It has been calculated that about $3\frac{1}{2}$ acres of a normally stocked forest can

provide in perpetuity all the primary physical requisites of an adult to keep him in comfort.

12. Viewed against these varied trends of wood utilisation, our own enterprises in wood products are still in their infancy. The village carpenter is a useful member of the community. The Indian craftsman with his wood carving is justly world famous. The trade in wood products is considerable. But our wood industries are still nascent. And, efficiently *integrated* wood industries are yet to be built up. There is no good reason why these should not develop much and far. We can expect that wood will take its rightful place in the national economy of the country that is now being planned. The per capita annual consumption of wood is a fair index of the purposeful use of wood in ensuring an adequate standard of living for the community. Even if we leave out the Scandinavian countries where wood economy and consumption is exceptionally high (Finland has 102.26 c. ft. and Sweden 64.6 c. ft. of wood consumption per capita per year), the following figures reveal a telling tale. The annual per capita consumption of wood is in Switzerland 31.1 c. ft., Czechoslovakia 8.4, prewar Germany 20.8, Great Britain 20.5, France 11.3 and the United States 16.0. Unfortunately, I have no figures for India, but there is no doubt that our corresponding figure is very low—probably not even as much as 1.0. c. ft. per capita per year. The raising of the standard of living of the common man implies that our consumption of wood product must need go up.

13. May I venture a peep into the future ? Lignin has so far been the problem child in wood utilisation. Compared to its twin brother, cellulose, lignin is now largely a waste product although its first rather elementary uses as fuel and road binder have now been extended to its application as a binder in mixing concrete, a base for fertilisers, in storage batteries and in plastics. The Chemist is not yet quite sure of the structure of lignin. And, it is likely that with the unravelling of its chemical constitution, lignin will find uses no less varied and startling than cellulose.

14. In his long, long history, man passed through the Stone Age, the Bronze Age, the Iron Age and the Machine Age. Each of these Ages cover periods when the concerned material was used in a way to give an individual character to mark out the era. Right through all these Ages, wood has been the good ally of man. With so impressive a record of wood products behind us and promise of even a more fruitful future before us, we to-day make so many products *of* wood and *from* wood that our present Age may well appear in perspective to the future historian as the Age of Wood.

MORNAULA-PAHARPANI-SUNDARKHAL MAN-EATER

By Beeson Abraham,

Retired P.C.S., Haldwani

This is an account of the depradations of the man-eater which had been operating in the border *patties*, namely Purabi Agar and Chaubhainsi in Naini Tal district and Malla Salam of Almora district, for about five months.

These places lie at an altitude of over 7000 ft. and are covered mainly with dense oak and *Rhododendron* forests with patches of interspersed cultivation. Nothing compares with the natural scenic beauty of these lofty heights overlooking Muktesar-Almora-Khali Binsar and extending far across into the majestic Himalayas with Debguru on the north, Debidhaura on the east, Deotal and Jhilling orchards on the south and the low-lying valleys extending right up to Ramgarh fruit gardens on the west. In this region a man-eating tigress had established her home and created great havoc and terror disorganising the normal life of the people. While elsewhere, where life is far easier and more comfortable, criminals among the human race perpetrate heinous crimes, in our hills where only bread earning is a task and life is otherwise peaceful and the climate bracing, the hill-side is sometimes subjected to the scourge of a wandering terror in whose code of jungle laws there is no sentence lighter than death, and the execution of the innocents is done without enquiry or trial. The liquidation of a man-eater in the hills is by no means an easy job as the numerous

chasms, caves and ravines of the hills provide it with ample hide-outs which are not within easy reach of sportsmen.

The district authorities were very anxious for the early liquidation of this monster; they published rewards for its destruction and also gave full facilities to the local shikaries and licensees and also told me to do my bit. I went over to the man-eater's country early in February under the most unfavourable weather conditions and set off to make enquiries regarding its whereabouts with a view to destroy it by any method practicable. To this end I worked with a team of two A.P.'s and four licensees.

My inspection of the scenes of human tragedies and spot inquiries revealed the following information about the persons killed and the manner in which they were done to death :—

1. **Bangi Charka** (Harinagar, Naini Tal district). The brute killed the young man while he was collecting oak leaves. This was considered to be accidental death. The body of the victim was rescued and recovered the same day after some time. One leg had been eaten up, and the remaining portion of the body was collected for cremation.

2. **Basia** (Almora district). The tigress killed a woman while gathering oak leaves. Her partly-eaten body was recovered the next day and cremated. The victim left a eight months old baby behind. Till the occurence of this tragedy normal activities of village life had not been disturbed and the women folk went into the fields and forests far and near to cut fodder and firewood breaking the monotony of the silent jungles with their national song which runs as follows :—

" My native country thee, Land of the noble free,
Thy name I love,
I love thy rocks and rills, thy woods and templed hills.
My heart with rapture thrills, Like that above. "

While the men enjoy hot tea at the village tea-shops playing cards and indulging in idle talk, the hard and tough work of the man falls to the lot of the women. Besides other household duties, the women do their difficult job cheerfully and are also most devoted wives.

3. **Raul Jagal** (Naini Tal district). The man-eater killed the widow while she was cutting wood. The victim parted from five children, the youngest of whom was about two years old. The splintered bones of the victim and her earrings, necklace and torn garments were found on the seventh day after she disappeared. Her tresses of long hair had been caught up in the thorny bushes while she was being dragged. It was after this tragedy that the common belief of the people that a man-eater was operating was finally confirmed. Thereafter fear and terror became so strong that measures were adopted to send the women to collect fuel and fodder in the forest only in groups accompanied by two or three gunmen and drummers whose duty it was to keep strict watch over the man-eater and scare her off by beat of drums and gun-shots. Then every bit of domestic squabble was shaken off and the womenfolk set out in groups like members of one family to do their outdoor work. Those living in isolated hamlets in the forests returned to their parent village with all their belongings to be reunited and suffer along with the others. Displaced though they were, the womenfolk still cherished the idea of return to their parents and to their " home sweet home " and gave vent to their feelings by singing the following song :—

" The head must bow and the back will have to bend,
Wherever the donkey may go,
A few more days and the trouble all will end,
In the fields where the potatoes grow,
A few more days for to tote the weary load,
No matter, twill never be light,
A few more days till we totter on the road,
Then my old country home far away. "

4. **Paharpani** (Naini Tal district). The brute killed a woman, an expectant mother (husband having died about three months before), who left seven children, the youngest being two years old. While returning with a load of grass along with her small daughter and other women the whole party rested for a while. The victim finding that the grass bundle of her daughter was too small, tarried to cut more grass and while in this act she was carried away by the man-eater. A rescue party was arranged the next day and her partly eaten body was recovered. The man-eater, however, did not touch the seven month old baby in her womb. The mother's remains and the child in the womb were carried together to the grave. Every person in the locality was by now in a state of abject fear, and this became so great that it forced them to seek refuge in Providence.

Their inner feelings were expressed in the following words :—

> "When darkness deepens, when other helpers fail and comfort flees,
> Help of the helpless, Oh ! abide with me."

5. **Arukhan** (Almora district). Another woman was killed. Her body was recovered the next day. Only her legs had been eaten up; the remaining portions were cremated. None sat up over the kill.

6. **Sundarkhal** (Naini Tal district). A widow having 11 children—youngest being 1½ years old—was killed. She was Padhan's aunt—her husband having predeceased her by 8 months. The body was rescued and recovered under gun fire and beat of drums after a short while. She had been dragged into heavy undergrowth—all her garments having been stripped off by thorny thickets. Her body lay nude on its back, and it was then covered with a white sheet. Four shikaris sat up the whole night. The man-eater walked in circles near about, growled on seeing the white cloth, and in rage and fury tore off the scattered blood-stained garments, but it did not come to the kill. Next day the body was removed for cremation. The man-eater selected persons in full health for its victims. One demented person named Harku had been wandering from house to house till late at night when everyone else was within locked-up doors, but the man-eater spared him as, according to common belief, he had been placed on its list of exempted persons.

7. **Sasbani** (Naini Tal district). Five days later a stout young man was killed while gathering oak leaves with his womenfolk. So sudden and unexpected was the attack that the victim had only time to raise a choking cry once before he was killed. When the woman heard his agonised cry they screamed and the *padhan* fired his gun from the village, whereupon the man-eater left the body after sucking blood. In a short while several people collected at the scene of the kill. Three shikaris sat up for one full day. The man-eater saw the *machan*, kept snarling and moving the undergrowth but did not come to the kill. Next day H.C. Malak Singh and Constable Himmat Singh, A.Ps. detailed by the Superintendent of Police, Kumaon, sat up, but the man-eater behaved in a similar manner. Third day H.C. Malak Singh and Th. An. Singh a renowned shikari, changed the position of the *machan* and just when the man-eater was heard coming to the kill, two gun-shots went off from the nearby village (this was usually done when any one wanted to ease himself at night) whereupon the man-eater dashed off with one bound and did not return that night. Next day due to heavy rainfall no one could sit up and so a trap of loaded guns had been laid over the kill. The guns went off at midnight without any result. This incident made the man-eater more crafty and clever and rightly so as it perhaps found to its great astonishment that not only a living man also even a rescued dead person was able to discharge a gun. From that time onwards the man-eater also changed its tactics, in that it ate as much as it could of the victim till he or she was rescued or recovered, but did not return afterwards. The corpse was now showing signs of decomposition, but due to fall of hailstone overnight, the firewood could not burn and so a grave was dug, the coffin laid in it and dust mingled with dust with a salute of one gun shot.

8. **Basia**—Again a widow was killed. She was mother of 4 children the youngest being one year old. She was killed and carried away in the immediate presence of a young boy on a tree who was cutting leaves for her. He got so stunned and paralised that he could not raise an alarm, but fell down the tree after the man-eater had disappeared with its victim. After regaining consciousness he took to his heels and informed the villagers of the incident who rescued the remains of the victim the next day and cremated it. No one sat up for the man-eater.

9. **Mehtoli** (Naini Tal district). Five days later another widow was claimed by the man-eater. She left behind 2 children, youngest being 1½ years old. She ws also killed in the immediate presence of her sister-in-law who witnessed everything and lost her balance of mind. Staggering she went to her brother-in-law who was ploughing the fields below and stood speechless and when shaken up by him she related the incident in tears. She actually recovered from her shock the nex day. The man's blood boiled in rage and he went after the man-eater for some distance when it was going up and down the valley with its victim; in the meantime help arrived and they succeeded in rescuing the body. Four greedy shikaris sat up but were unable to decide amongst themselves as to who was to take the first shot, and this went on till midnight in the midst of smoking, coughing and bombarding on the *machan* due to the severe cold. As the man-eater could not put up with this nonsense, it refused to return to the kill and so the disagreed assessors descended, lit a fire near the kill for the rest of

the night and left for home when day dawned, in utter disgust. The body of the victim was thereafter cremated.

In all these cases the man-eater dealt a blow on its victim from behind with her massive fore-paw simultaneously catching hold of the victim by the throat and neck, smashing the cervical vertebra thereby causing death in a second and giving no time to breathe or cry. Efforts to rescue the victims alive were altogether futile.

Besides the above known and recorded casualties, there were others of unknown solitary *Dotial* coolies not rescued or recorded.

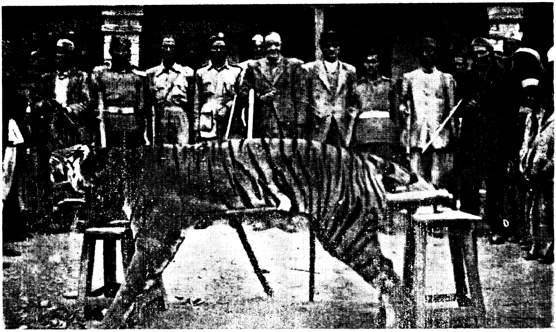
I remained in the man-eater's country in February for 18 days, but could not get an opportunity to sit over a kill though it was quite usual for the brute to claim a victim once in 10 to 15 days. During my stay I resorted to every conceivable trick or method to entrap the brute. Tracks of the man-eater were followed, *katra* baits tied up, but not taken, human dummies set up but never approached, imitation calls emitted but not answered and finally with 2 A.Ps and 4 licencees we scoured the country together with me as the leader and the Police party bringing up the rear—and scanned every bit of the jungle step by step, its chasms, caves, heavily wooded ravines and series of grassy slopes where a false step would have resulted in a broken limb or death. The other jungle game was either so hopelessly exterminated or left the jungles through fright that no alarm signal was ever raised by any of them. Even our best guides and watchers (apes and monkeys) were nowhere to be found. When all hopes of meeting the man-eater failed, I returned to Haldwani to take rest promising the people to come again in case it was not liquidated meanwhile by any of the local shikaris.

During my stay in the forest I visited most of the scenes of human tragedy, meeting the orphans (from babies to grown-ups) left stranded in life. Their hearts were full of grief and their eyes dim with weeping. Their tales of woe and anguish, were simply heart-rending. Those on whom has devolved the duty of bringing up the orphans in addition to feeding their own mouths have no relief or peace of mind. Motherless babies cried bitterly for the embrace of the gentle arms of their mother and nurse and for being put to sleep by her favourite lullaby song :—

" Sleep on my baby—my precious child—night falling fast, Darkness surrounding—angels guarding-mother by your side. " Alas? the beloved mother is gone, gone for ever, never to return. Their priceless treasure in this world is lost. No words can describe the state of anguish and travail of these parentless children left destitute in life.

After I landed at Haldwani a message followed me up to say that a woman had been killed at Basia, 14 miles away from Managhair (my base camp) and that the 2 A.Ps. has already proceeded to the scene of the tragedy. Five days later news of the killing of another woman (Victim No. 9) in Mahtoli reached me. Though the shikaris were sitting up over the kill my friends in Haldwani implored me to go again as they did not expect much from them. As the crafty man-eater was once again active, I decided to go, and after packing up my camp kit I left on the 9th of March. People enroute wished me good-luck. While toiling up the mountain climb, I surprised a naked fakir (Nagar Baba) who was observing complete silence by greeting him with 'Jai Hind '. He was lying on his side, with drawn-up knees, and with his buttocks turned towards the forest. He sat erect apparently annoyed at my intrusion. On my offering him a smoke, he smiled and I asked him if good-luck would attend me this time and, he raised his two fingers to form a V and shaking his hand directed me to go forward. I met other fortune-tellers some foretelling bad luck some good luck, but the earlier predictions of the naked Baba with the V (signifying Victory) gave me hopes of success this time.

After a long and strenuous up-hill journey I reached my headquarters at Managhair, to the great delight of my friends. Due to inclement weather (snow having fallen overnight and to my great delight) my progress was retarded for the next two days. By this time a section of P.R.D. volunteers detailed by the S.D.M., Naini Tal, to work under my directions, also arrived. They were told off to duty at different posts. I was much impressed with the guts and initiative of the young volunteers who, though yet new to the job of dangerous game hunting, were very eager to profit by my long experience. I told the youngsters fired with the zeal of hunting (and at the same I write for my young readers) that the knowledge necessary for success in shikar can only be acquired by long practical experience, and must be sought for painfully and laboriously in the fever-stricken jungles, on the snow-swept prairie, in the solitude of the backwoods, on rolling veldt or precipitous



Man-eater lying in state with armed guard and its assailant.

mountain peak like what I had had, earlier in life, in company with Messrs. Wyndham and Jim Corbett in organizing many a big game hunt for the erstwhile Viceroys and Governors of India. The constant pursuit or big game develops in a person physical, mental and moral qualities of no mean order, and it entails absolute soundness of mind and limb, perfect control of temper, leonine courage and a high degree of patience.

To continue, I set off to explore the ground for fresh tracks and found them near Paharpani 4 miles away and I moved my kit there after seeing the stale kill of the *Katra* which had been tied up but died a natural death due to cold. The kill had been removed by the hungry man-eater after my departure to Haldwani, but the pug-marks of the man-eater on the soft ground nearabout the kill were similar to those found on the scenes of human tragedy; they were of a tigress. The track led to the plantation near Paharpani where I arranged for a beat on the off-chance of meeting it, but it did not turn up. While returning disappointed to Paharpani a special messenger came running from Darmande to say that the man-eater was seen stalking three shepherds who were tending cattle on the border of the village, that it made an attempt to lift one of them, but that this was foiled by their joint concerted shouts, hurling of stones and cries for help. The man-eater having failed to kill one of the men, caught hold of a cow by the throat and killed it. Meantime help arrived and they all succeeded in driving away the brute from the kill. Then a fire was lit and 2 men climbed a tall tree to keep clapping and shouting to prevent it dragging off the kill. Without a moment's delay I dashed off to Darmade and landed on the spot, hot and dishevelled from rough scramble, at 6 P.M., got a *machan* 8 ft. high made on the solitary oak tree and climbed on to it alone with H. C. Malak Singh A. P., and told the others to go away talking. Sitting with knees drawn-up, on poles and with my shirt soaked with sweat was beginning to tell on my nerves, but every bit of inconvenience had to be put up in the hope of bagging the man-eater. At 6-40 P.M. on 17th March, a crack of dried twig heralded the tigress's arrival; my rifle had been kept in readiness for her. She broke cover and taking the *Nala* with a bound, came cautiously and majestically occasionally raising and lowering her head and looking up at the trees when she suddenly paused giving me full view of her at a distance of 60 yards; without waiting any further I fired hitting her on her back. She fell over the young plants, snarling hideously, like the drone of spitfires about to hurl bombs, and biting and tearing the young trees which hid her from my view. I at once stood up on my *machan* to look for her; she spotted me and in her rage and fury with ears laid flat and teeth bared she attempted a charge, upon which I fired again hitting her on the head; she fell flat and lay motionless. I fired one more bullet to complete the volley of the funeral salute in her honour. Three reports—like cannons-fired from 450-high velocity rifle (a heavy weapon to carry in the hills, but one having no equal its striking power) resounded across the hills and valleys conveying to the people in the country the message that their dread enemy had been killed. On hearing the reports of my rifle) anxious and impatient-crowds of villagers rushed to the spot with torches and flares and their joy knew no bounds on seeing the tigress lying dead. We got down from our *machan* and approached the tigress, and with folded hands I saluted the tyrant 'Queen of the Jungle' and thanked Providence for the successful termination of my mission in relieving humanity from the suffering, the scourge and the menace of this notorious wandering terror.

Soon our quarry was leashed to a pole and carried on human shoulders amidst great rejoicings and shouts, to Padhan Bir Singh's house and kept under strict guard; in the early morning the 'ALL CLEAR' was sounded and broadcast by beat of drums and gunfires, which summoned the villagers to join in the funeral procession, and in no time hundreds of people gathered to see their enemy, and joined hands in carrying the carcass to Managhair on the main road.

The man-eater was a tigress of average size—measuring 9'-6" past her prime, slim in body, but having a beautiful coat. She was laid in state till 5 P.M. and hundreds of men, women and children came singing and shouting as only their own eyes could satisfy them that the monster was really dead (see p. 430-A). The post-mortem examination revealed that she had been fired at before. She had three old gun-shot wounds. One hand-made bullet was extracted from the base of the neck and two buckshots from behind the right ear and the abdomen. They had adhered to the flesh just underneath the skin. These wounds had made her turn into an established man-eater, perhaps out of rage and revenge. Her fat was yellow like that of human beings and her stomach and intestines were empty due to hunger; so she had contented herself with

killing a cow as a last resort. The last victim claimed by her had been on 26th February.

As this was an opportune occasion for giving advice, I sounded a note of warning to the licencees that they should, on no account, attempt to kill carnivora with buckshot or slugs and also never to shoot the females of any pot-game.

The rosy-cheeked, bare-footed children who came to see the enemy which left them destitute, wept bitterly and left after thanking me for avenging the deaths of their beloved mothers. Folk-dances around the bonfire which had been lit kept the spectators busy till late in the evening and finally the show ended up by singing:—

"Jahan duniya badalti hai, isi ka nam duniya hai; Kabhi dukh hai, kabhi sukh hai, abhi kya tha, abhi kya hai."

Calm descends; the storm is over and the Great Day with its rejoicings and solemnities, along with the black record of the man-eater, will remain stamped upon the minds of the people for ever. After receiving the good wishes and benedictions of the people I retraced my steps.

EXTRACT

SALUTE TO THE TREES

By Henry Van Dyke.

Many a tree is found in the wood
And every tree for its use is good;
Some for the strength of the gnarled root;
Some for shelter against the storm,
And some to keep the hearth stone warm;
Some for the roof and some for the beam,
And some for a boat to breast the stream;
In the wealth of the wood since the world began
The trees have offered their gifts to man.
But the glory of trees is more than their gifts;
'Tis a beautiful wonder of life that lifts
from a wrinkled seed in an earth-bound clod,
A column, an arch in the Temple of God,
A pillar of power, a dome of delight,
A shrine of song and a joy of sight
Their roots are the nurses of rivers in birth;
Their leaves are alive with the breath of the earth;
They shelter the dwellings of man; and they bend
O'er his grave with the look of a living friend.
I have camped in the whispering forest of pines,
I have slept in the shadow of Olives and vines;
In the knees of an Oak, at the foot of a palm
I have found good rest and slumber's balm.
And now, when the morning gilds the boughs
of the vaulted elm at the door of my house,
I open the window and make salute;
"God bless thy branches and feed thy root
Thou hast lived before, live after me,
Thou ancient, friendly, faithful tree".

(Contributed by R. C. Morris).

EXTRACT

SALUTE TO THE TREES

BY HENRY VAN DYKE.

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And every tree for its use is good ;

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INDIAN FORESTER

NOVEMBER, 1949

INDIA'S GIFT TO FORESTRY INSTITUTE

Opening By Princess Margaret Rose

Gifts of timber from all parts of the Commonwealth have been used in the construction and furnishing of the new Imperial Forestry Institute building at Oxford University which will be opened by Princess Margaret today (October 19). India's gift of rosewood has gone into the making of furniture for the Institute's committee room.

The Institute has 14 different kinds of floor and panelling and furniture in several different kinds of wood from Commonwealth countries. These gifts provide not only a visible token of the help and goodwill of the donors but will also be valuable in themselves as a much more effective exhibition of timbers than would have been the collection of specimens in a museum which it was at one time proposed to include in the new building but which was later omitted from the plan.

COMMONWEALTH CENTRE

The Institute is a Commonwealth centre for forestry training and research and for exchanging information on forestry matters. Founded in 1924, the Institute has until now been housed in temporary accommodation. When plans for the new building were completed, the war intervened so that it was not until 1945 that work on it could begin.

There is a close association between the Institute and India for its origin dates back to 1905, when a School of Forestry was founded at Oxford following the closing of the Royal Indian Engineering College at Coopers Hill, near Windsor, where probationers for the Indian Forest Service had been trained during the previous 20 years. The school carried on the training of forest officers for India.

For the first four years all probationers for the Indian Forest Service were trained at the Oxford School but later recruitment was extended to include men whio had passed through the recently opened unversity schools at Edinburgh and Cambridge.

When in 1933 recruitment in Britain for the Indian Forest Service practically ceased, the need for the Colonial Forest Service largely took its place and the launching of a large forestry programme in Britain provided further openings.

ESTABLISHED IN 1924

The Imperial Forestry Institute came into being in 1924 following an Empire Forestry Conference in London when the need was stressed for a centre where special facilities for post-graduate instruction and study could be provided for those parts of the Commonwealth where facilities were not likely to be available for some time to come. The Institute was linked with the existing School of Forestry and additional temporary accommodation acquired. In 1938 the School and Institute were brought together within the University Department of Forestry.

The new building will house both the undergraduate and postgraduate sides of the Department, as also the Commonwealth Forest Bureau. This is a unit of the Imperial Agricultural Bureau and although a separate organisation from the Institute is based on the Institute's comprehensive library. The Bureau was set up in 1938 to meet the need for an efficient referencing service covering all forestry literature both at home and overseas.

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NOTE ON WATTLE PLANTATIONS IN BOMBAY STATE*

By I.M. QURESHI, B.Sc., A.I.F.C.,

Silviculturist, Bombay, Poona.

Need for Wattle Cultivation.—Wattles are species of genus *Acacia* (Mimosae) of Australian origin which have been successfully cultivated in South Africa since about the middle of last century. Wattle cultivation is now the largest of the local forest industries to be maintained exclusively by private enterprise, having a total afforested area of more than half a million acres. The chief value of wattles lies in the important tan bark of the trees obtainable within a short rotation of 5 to 8 years, the wood being used as firewood as well as employed for mine-props. Wattle Industry has grown and expanded so much in South Africa as to lead to the establishment of a Wattle Research Institute. The plantations have been so well-managed that even Australia, the home of wattles, has found it necessary to import some 3000 tons of wattle bark annually from South Africa. This indicates the supremacy of tan barks over other tanning materials, the average costs of bark being as high as £10 per long ton (2,240 lbs) in 1945. Wattle bark contains an astringent catechol tannin which is particularly used in sole-leather manufacture and can be also used successfully for light leather. The colour of the leather obtained is much less red than that produced by many other catechol tans. It is recorded that the tanning liquors produce very little acid on fermentation and consequently do not plump well, thereby making wattle a good blend with acid-producing tanning materials, such as myrabolams. Wattle leather is also firm and durable. In view of these properties of wattle bark, majority of countries import bulk supplies of wattle tan, either in the form of bark or tannin extract. India also imported large quantities as can be seen from the following figures available from 1913 to 1926.

Indian Import of Natal Bark

Year	Quantity (Cwts.)	Year	Quantity (Cwts.)
1913-16	25,952	1921-22	23,603
1916-17	35,433	1922-23	9,440
1917-18	55,366	1923-24	11,685
1918-19	20,731	1924-25	21,392
1919-20	57,738	1925-26	97,077
1920-21	41,934		

Even in Madras, where indigenous tannin species like *Cassia auriculata* Linn. and *Terminalia chebula* Aetz. (Myrobolam) occur abundantly in drier districts, the average value of the annual import into Madras of "Wattle Bark" was over 10 lakhs of rupees in 1936.

Experiments in Bombay State.

Considering these essential requirements of the country, particulalry at a time when trade relations with South Africa are strained, it is imperative to undertake cultivation of Wattles in suitable areas. The first attempts in this direction in Bombay State were made in 1948, on an experimental scale, over an area of 16 acres at Londa and Teregalli in Khanapur range of Belgaum division. The species selected was *Acacia mollissima* Willd., the Black Wattle, which gave very encouraging results. The average height of plants in one season was over 6′. Trials with a few seedlings of *Acacia pycnantha* Benth. was the golden wattle and *Acacia decurrens* Willd., the Green Wattle, were also made but with unfavourable results. In view of the success achieved in 1948 by artificial planting of black wattle, the plantations were extended by 20 acres in 1949 rains and this year another 30 acres have been selected for 1950 rains. A brief account of the nursery technique and method of planting employed etc. is given below:—

Choice of species.—There are four species of wattle which are commercially important. They are:—

(1) *Acacia pycnantha* Benth., (the Golden Wattle)—This is known to possess the highest tannin content up to a maximum of 50% with an average of about 38% in the air-dried material. It is also known as "Adelaide bark". Inspite of its high tannin content, this species is not favoured, even in South Africa, owing to its very slow growth. Golden wattle occurs principally in South Australia, and to a smaller extent in Victoria and the South-West of New South Wales.

* Received from publication on 24-2-1951.

(2) *Acacia decurrens* Willd., (the Green Wattle)—The species has not been found to grow well in this state though in South Africa it is reported to grow vigorously giving about 31 to 39% tannin. But its bark contains a higher proportion of red and yellow colour units than that of the black wattle (*Acacia mollissima* Willd.) and consequently imparts an undesirably dark colour to leather. It is this reason that it is not raised as extensively as black wattle even though it is more resistant to the two major insect pests of plantations.

(3) *Acacia mollissima* Willd; (the Black Wattle).—This is the species which has been found to grow well in this state and it is also the principal wattle of South Africa with a tannin content of about 37 to 43%. The climatic, edaphic and silvicultural requirements of this species are given in succeeding paragraphs. *Acacia decurrens* and *Acacia mollissima* were previously regarded as two varieties of the same species but now they have been regarded as two distinct species.

(4) *Acacia dealbata* Link; (the Silver Wattle). —The bark of this species is poor in tannin content (about 20%) and quality and hence its sale under the name of black wattle is not permitted in the Union of South Africa.

Source of seed-supply.—Seeds were got from Kenya and Australia in 1947, a year previous to planting. The seeds weighed 2180 per ounce.

Pretreatment of seed.—Like seeds of most of the Acacias, and Leguminoseae family in general, untreated wattle seed germinates very poorly due to its hard testa but if hot water treatment is given excellent germination, as high as 50-65%, is obtained. This consists of a simple process of bringing to boil a sufficient quantity of water which is then taken off the fire and the seed is immediately dropped in it and left for about 12 hours, after which the water is decanted and the seed freed of its mucilaginous coating, produced due to soaking in of water, by rubbing with a gunny bag or little dry sand. The seed is then washed with cold water and thoroughly dried before sowing or storage. The pretreated seed does not deteriorate even if stored up to at least one year after treatment. This is highly important from the foresters' point of view.

Nursery technique and potting of seedlings :—The pretreated seeds are sown on raised nursery beds 20′×4′ in lines 3″ apart at the rate of 3-4 ozs. per bed and watered regularly. The seed starts germinating within 7-10 days and germination is complete by about a fortnight. When the seedlings have attained a height of 4″ to 6″ they are pricked out into bamboo tubes about 10″-12″ long with 3″-4″ diameter, prepared out of the locally available—*Bambusa arundinacea* Willd. culms. The bamboo tubes are first split longitudinally right to the bottom, up to the basal node, but not completely broken into two halves. They are then filled up with loose soil and one seedling is planted in each tube. They are kept in a shady place, and watered regularly. In order to avoid the seedlings striking root into the ground through the side-*splits*, the position of the bamboo tubes is shifted once in a week (Fig. 1).

The development of seedlings in the tubes is fairly satisfactory and gives suitable stock of transplantable size within 6 to 9 months. With a view to finding the best time of raising stock, and consequently the best age of transplanting nursery raised seedlings, the seed was sown in September and also in December to get 9 and 6 months old seedlings respectively by next June when the transplanting is done at the commencement of first regular monsoon showers. 18-month old stock of the previous year was also tried. From the results it appears that 9 month old seedlings in bamboo tubes which are about 10″-12″ high, give the best results. (Fig. 2).

Another method of raising stock which has been found satisfactory and economical is to sow the treated seed direct in the bamboo-tubes. This method eliminates the cost of nursery work, pricking and potting. Half the area is being planted up this year by seedling raised direct in tubes.

It has been also found that direct sowing *in situ* in previously prepared soil gives equally good results. An acre has been so raised in Coupe 20, Block IV-4 of Belgaum division in 1949-rains, and the development of the seedlings is quite vigorous with average height of about 24″. In South Africa, too, the common method is direct sowing in ploughed-up soil. As direct sowing requires larger quanitity of seed and is also not so reliable under forest conditions as transplanting, the latter was followed in the early experiments as our seed supply was limited. Further experiments with direct sowing in *situ*, both with and without irrigation, are proposed to be undertaken in

1950-rains as this is apparently the cheapest method of starting a plantation.

Climate and Edaphic requirements of Black Wattle, The optimum climatic conditions for the healthy and vigorous growth of wattles reported for South Africa is a misty atmosphere in a region with an altitude between 2,000 to 4,500 feet and with a mean annual rainfall over 35 inches. As regards soil, wattle thrives best in a well-drained good, deep soil, varying in texture from sandy loam to loamy clay. In South Africa, the best plantations exist on deep red doleritic soils or soils of Table Mountain, Sandstone origin, particularly where there is an admixture of granitic detritus. In soils of shale origin and also very sandy or very clayey soils, the plants are liable to suffer from drought in hot weather. Adequate soil moisture coupled with satisfactory drainage and misty atmosphere are the important pre-requisites of successful wattle cultivation besides the mineral or geological nature of the soil. It is estimated that black wattle transpires regularly an amount of moisture equal to 40 inches of rainfall at the ordinary temperatures of Natal midlands. Therefore, the plantation will suffer at lower altitudes where atmospheric humidity is low and intensity of heat severe or in soils which are deficient in sub-soil moisture and cannot meet the water requirements of the species.

With a view to studying the growth of *Acacia mollissima* in both low and high rainfall areas of Bombay State experimental planting of the species was undertaken in Khandesh, Panchmahals and Poona divisions on the one hand, and Belgaum and N. Kanara on the other, with annual rainfalls ranging from 26″ in Poona to 150″ in Londa (Belgaum). It has been observed that the species grows poorly and finally succumbs to drought in the hot season in the low rainfall areas of Poona (altitude 1830′) Khandesh (altitude (500′—1000′) and Panchmahals (500′) where there is absence of misty atmosphere though the soil is fairly deep. Experiments were done on both alluvial, loamy and clayey soils but with little success. In Poona division, the species was also tried in the Agri-Silvi coupes at Pimpalgaon in Poona West range on alluvial-soil near the river bank together with babul (*Acacia arabica*) plants. The plants grew well till the plot was irrigated but with the harvesting of the jowar crop and consequent stoppage of irrigation, the seedlings dried up in January 1949, after about 9 months of growth. On the other hand, the development and establishment of the species was remarkable in the high rainfall areas of Londa and Shiroli (Teregalli) of Belgaum division where the altitude is 2092 and 2800 feet respectively and the climate is misty during monsoons and also in some parts of winter. The soil in this region is loamy at Londa and clayey at Shiroli.

Preparation of site and method of planting. The plantations of Black Wattle made at Londa and Shiroli in 1948 (total 13 acres) and in 1949 (total 20 acres) were located in current years' clearfelling fuel coupes where, after extraction of firewood and timber by the contractor, the brushwood and debris was collected, heaped and burnt in March-April. Pits of the size of 12″—6″—6″ were then dug in April-May and soil allowed to weather till the time of transplanting the seedlings in June-July at the on set of monsoons. The spacing adopted was 6′—6′ in 1948 and 9′×9′ in 1949 considering the fact that a closer spacing than 9′×9′ requires early thinning which does not bring any returns except adding to the cost of the plantation and as the aim is maximum bark production, which can be achieved by better diameter and crown development as a result of wider spacing. But it has been also observed that growth of weeds and grasses is more with wider spacing. The growth of weeds was therefore kept down to some extent in 1949 plantations by intercropping with *Oscimum kilimandscharicum*, a species yielding camphor and camphor oil.

Cultural operations, weedings, etc. The areas were fenced and entrusted to the charge of a watchman for whom temporary huts were constructed at Teregalli and Londa. Weeding started from the middle of August and included 2 *phawrah* scrape-weedings done as and when required but completed before January of the next year. During the rains several plants were found to suffer from damage either by fungus or insects. The diseased specimens were sent to Forest Mycologist, F.R.I., Dehra Dun, from which several fungi have been reported to be isolated and the investigation is still in progress. The insects—Wattle bagworm and Froghopper—were noticed in September November and were partly controlled by spray of tobacco-soap emulsion and gammexane dust. Gummosis was noticed in some vigorously growing stems in 1948—Teregalli plantation where the tallest plant attained a height of 12′–3″ after one season's growth. (Fig. 3).

The survival percentages in Teregalli and Londa plantations of 1948 were 62% and

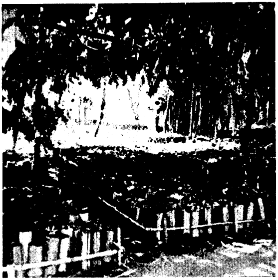

Fig. 1.

A close up of *Acacia mollissima* plants in bamboo tubes. The tubes are grouped in lots of 500 each.

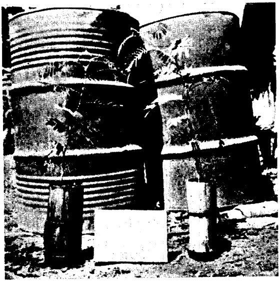

Fig. 2.

Two seedlings of *Acacia mollissima* 9 months old.

Fig. 3.

A close up of the tallest wattle plant at Teregalli; the 9 months old transplant, was 12'-3" high, 8 months after transplanting.

60% respectively while in 1949 the plantation at Londa gave as high as 70% survivals at the end of one season. Teregalli plantation of 1949 suffered heavily due to tall grass growth.

Cost of plantation and financial aspect of wattle-cultivation.

The following statement shows the expenditure, per acre, incurred on various items on 1948 and 1949 plantations.

3. At Teregalli only one coolie was utilised for the whole period but only 4000 seedlings were used whereas at Londa an additional one had to be engaged from January 1948; the cost is, however, less because of the greater number of seedlings (14,000) obtained.
4. The rates are more or less uniform.
5. In Teregalli area a truck was used to transport the seedlings over 2 miles, hence the higher cost. This year the rate is less because of smaller number of seedlings.

Items	COST PER ACRE			
	1948-49		1949-50	
Nursery	**Teregalli**	**Londa**	**Teregalli**	**Londa**
1. Seeds	2 0 0	1 0 0	0 8 0	0 8 0
2. Preparation of nursery beds. ..	15 12 0	6 0 0	2 4 0	5 0 0
3. Watering.	53 0 0	35 0 0	11 0 0	11 4 0
4. Bamboo tubes and potting ..	44 0 0	43 0 0	38 0 0	38 0 0
5. Transport to site	26 0 0	9 0 0	4 0 0	4 0 0
Site				
1. Reheaping and burning ..	31 12 0	60 0 0	60 0 0	60 0 0
2. Lining, staking and pitting ..	45 0 0	53 0 0	25 0 0	25 0 0
3. Planting.	12 0 0	12 0 0	5 4 0	5 4 0
4. Construction of hut.	12 4 0	4 4 0	*	5 0 0
5. Fencing.	13 0 0	16 0 0	16 0 0	20 0 0
6. Weeding (2 *phawra* scraping, soil stirring and line weeding) + insecticide	33 0 0	33 4 0	18 0 0	18 0 0
7. Fire tracing	19 4 0	16 12 0	10 0 0	14 0 0
8. Watchman	85 8 0	28 8 0	42 0 0	42 0 0
GRAND TOTAL	392 8 0	317 12 0	232 0 0	248 0 0

Reasons for variations in costs per item.

NURSERY

1. The steady decrease is due to experience gained regarding the germinating capacity of the seeds.
2. In 1948-49 it costs more per acre at Teregalli because 20 nursery beds were prepared and only 4000 seedlings utilised whereas at Londa 31 beds were prepared and 14000 seedlings were pricked out from them. This year just the requisite number were made in Londa and at Teregalli some of the old ones were utilised.

SITE

1. At Teregalli, in 1948-49 there was no material to be heaped and burnt—it was a grassy area.
2. Less cost this year because spacing is 9'×9' as against 6'×6' last year.
3. Same as above.
4.* Rs. 50/- were spent on a hut last year in both areas but since the cost is

distributed per acre it is lower for Londa (12 acres—against 4 acres at Teregalli). This year no shed is required at Teregalli because both the 1948-49 and 1949-50 areas are contiguous.

5. Rates are about the same.

6. Cost is less this year because *phawra* scraping has to be done round a smaller number of plants.

7. At Teregalli cost per acre was higher because of smaller area; this year it is less because of one side being common.

8. Rate at Teregalli was higher per acre last year because of smaller acreage. This year the watchman gets revised scale of pay and accordingly a literate intelligent man has been secured as against a coolie on daily wages last year, but he supervises both the areas (1948-49 and 1949—50).

It is hoped that as the work and plantation technique have now been almost standardised and the staff have acquired experience of the species, the initial cost of raising an acre of wattle plantation can be brought down still lower, *viz.* to Rs. 200/-. Subsequent work will entail comparatively less expenditure after the first crop is harvested. Further, if direct sowing in *situ* after ploughing is found successful, a good lot of expenditure on labour in trasplanting and potting can be also saved.

Plans for future extension: This is the beginning of the third year of our experiments with wattles. After watching the results of three years, the plans for future extension will be modelled accordingly. It is proposed to grow wattles on a territorial scale from 1951 onwards as the limited staff of the Silvicultural division, which has been in charge of the work uptil now, finds difficult to cope with the large scale plantations. The plantations both at Londa (20 acres) and Teregalli (13 acres) are at present looked after by one Research Forester with the assistance of a *mali* at each place.

The present plantations are situated in the same range in which the Bombay Wood Distillation Factory is operating. This augurs well for the future as large quantities of firewood are required for the Factory for which fast-growing dual-purpose species like wattles and Eucalyptus are the ideal choice. Wood of Black Wattle is reported to have a high alpha-cellulose content and therefore holds bright prospects as a raw material for the manufacture cf rayon and plastics. Uptil recently, wattle wood was regarded a waste material of the tanning industry but researches in other countries have revealed the possibility of producing acetone, methanol and pyroligneous acid from waste wattle wood. Experiments have also been carried out which indicate that wattle wood can be satisfactorily pulped for the production of kraft paper. In fact a factory is in the process of erection in Natal for the production of "Masonite" from wattle and other waste-timber.

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(3) Note on the Cultivation of the Green Wattle, *Acacia decurrens* in South Africa and South India—1939—by **M.S. Raghavan.**

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A BRIEF NOTE ON SOIL AND WATER CONSERVATION MEASURES IN HOSHIARPUR DISTRICT AS AFFECTING THE GROW MORE FOOD SCHEMES

BY JHUNNA SINGH, I.F.S.

Chief Conservator of Forests, Punjab.

1. Water Conservation and Forests.

The second half of the 19th century witnessed heavy disforestation in the Siwaliks. When the Cho menace and lowering of water table had assumed serious proportions, the administration put its faith in reafforestation and enacted the Land Preservation Act, 1900. Clause 3 of this Act reads as follows :—

> "Whenever it appears to the Provincial Government that it is desirable to provide for the *conservation of sub-soil water or the prevention of erosion* in any area subject to erosion or likely to become liable to erosion, such Government may by notification make a direction accordingly."

2. Public attitude.

But as the work was entrusted to Civil Authorities and nothing was done to educate public opinion, no headway was made with closures or afforestation till the thirties of the present century when the Forest Department was put in charge. Persons affected by closures, which now cover almost the entire Siwalik range, have wrongly tried to raise doubts about the efficiency of the measures taken, but the following extract from the Commissioner of Jullundur's letter No. 149/S.H.W. dated 12-3-1944 is very significant.

> "......it appears to me to be quite possible that the amount of reafforestation which has already taken place in the Siwaliks has now turned the scale in favour of parallel rise in the sub-soil water of the whole of the Bist Doab. This is a matter of the very greatest importance in connection with the outstanding problem of Hoshiarpur and Jullundur districts ; that of the fall in the sub-soil water level. It affects the prosperity of about two million people."

3. Verification of belief.

As doubts still persist and we are passing through a period of acute financial stringency, it has become necessary to convince all that the soil conservation measures are really effective and producing results as anticipated. A rapid survey of the area carried out by the staff of the Hoshiarpur forest division has brought to notice 600 wells scattered all over the district, which have shown rise of water table from 1 to 25 feet. 52 of these wells were completely dry over 10 years back, just as was the well in the compound of the Divisional Forest Officer which now contains about 8′ of water.

4. Achievement.

In the preceding paragraphs only one achievement of the soil conservation measures, that is rise of sub-soil water, has been considered. This rise has enabled fuller irrigation of the lands as well as additional irrigation of 221 acres by the wells, visited. As the rapid survey carried out was only exploratory, the figures of additional irrigation are more or less symbolic of improvement. Actually the whole of the Doab right up to Jullundur itself has shown this improvement and increased facilities for irrigation are of a very much higher order. It is proposed, in continuation of this interim report, to continue a systematic investigation of the rise in water table of every village in Hoshiarpur district of which a report will be published in professional and other papers.

Inside the hills, several springs have revived and streams flow longer both in duration and distance making drinking water more easily available to the villager and his cattle.

Over 200 square miles have been reclaimed from Cho beds, but most of this land is not yet fit for agriculture and has to come first under forests.

A MODIFICATION OF VON MANTEL'S FORMULA.

By A. B. RUDRA,

*Student, Indian Forest College**.

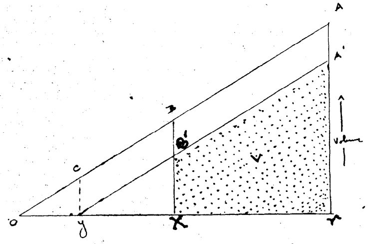
The correct application of Von Mantel's formula, annual yield $= 2 . \frac{G.S.}{r}$, requires complete enumeration and measurement of the total growing stock. The practical limitations to the above conditions resulted in various modifications of the formula *viz.* those of Howard, Smythies, Simmons and Blanford.

Howard enumerated the crop down to a diameter corresponding to half the rotation, while the measurement of the volume included the total volume of the trees. Smythies modification was based on enumeration of the crop down to a certain diameter, while the volume measurements took only the utilizable timber into consideration, the latter being fixed down to the same diameter limit. Smythies' premises were based on the practice in Uttar Pradesh. Simmons and Blanford generalised and modified the orginal formula for enumerations down to any size but included the total volume of the trees for the purposes of yield.

In general, however, the limit down to which enumerations are carried out need not be the same as that down to which volume measurements of trees are included. It may be sufficient to enumerate down to a size corresponding to an age say x, whereas the utilizable bole may be down to a size smaller than that corresponding to x.

Let, then, the enumeration be carried down to a diameter corresponding to an age x. Consider the volume measurements to be carried down to a limiting size (the upper part of the tree above this diameter being not measured) which corresponds to an age y.

In the adjoining figure assuming that the current annual increment of each wood is i, and is throughout equal to the final mean annual increment the volume of the growing stock is represented by the area of the $\angle$ o A r. The volume of the crop measured is evidently the area of the figure B'A'rX, where B'A' is a line parallel to oA and passing through y. Let this volume be V.



Von Mantel's formula is evidently not applicable to this limited growing stock but is only applicable to the whole growing stock. Consequently, to apply Von Mantel's formula it becomes necessary to express the growing stock in terms of V.

Now:

$$V = \angle\ oAr - \angle\ oBx - par^{m}.\quad BAA'B'$$

(where $\times$ B'Bis drawn at rt. $\angle$s to or)

$$= \frac{ir^2}{2} - \frac{ix^2}{2} - i.y\ (r-x)$$

* Received for publication on 16-11-1949.

because, area of the $\angle$ oAr $= \frac{1}{2}$ base $\times$ altitude

$$= \frac{r}{2} \times ir, \angle oBx = \frac{x}{2} \times ix,$$

and par^{m}. BAA'B'=BB' $\times \perp$ distance between BB' and AA' = CY $\times$ (r—x)
(where CY is $\perp$ to or at y) = i.y. $\times$ (r—x),

$$\therefore V = \frac{i}{2}\left\{ (r^2-x^2) - 2y\,(r-x-) \right\}$$

$$= \frac{i}{2}\left\{ (r-x)\,(r-x-2y) \right\} \ldots\ldots (i)$$

also, growing stock = $\angle$ oAr $= \frac{i}{2} r^2 \ldots\ldots (ii)$

$$\therefore \frac{\text{Growing Stock}}{V} = \frac{r^2}{(r-x)\,(r+x-2y)} \quad (iii)$$

Then, from Von Mantel's formula,

$$\left(y = \frac{2\,G.S}{r} \right) \text{ we have}$$

$$\text{Annual yield} = \frac{2}{r} \cdot \frac{V.r^2}{(r-x)\,(r+x-2y)}$$

(vide (*iii*) above)

$$= \frac{2\,V.r}{(r-x)\,(r+x-2y)} \quad \ldots\ldots\ldots\ldots (1).$$

It will be seen that the volume of trees whose diameter at breast height is less than that corresponding to x, and more than that corresponding to y, is not included. But the volume of the utilizable bole of such trees is very small and will not affect the results to any appreciable extent.

Two special cases may now be considered.

(*a*) When the crop is enumerated down to x but volume measurements include complete boles of the trees *i.e.*, y=0 —
The modification (Equation 1) then gives—

$$\text{annual yield} = \frac{2\,V.r}{(r-x)\,(r+x-2xo)}$$

$$= \frac{2\,Vr}{(r-x)\,(r+x)} = \frac{2\,V.r}{(r^2-x^2)} \quad \ldots\ldots (1a)$$

This is *Simmon's Modification* :—

(*b*) When enumerations and volume measurements are both carried down to a size corresponding to an age x, (Smythies premises *i.e.*, x=y.

The modification then gives—

$$\text{annual yield} = \frac{2\,V.r}{(r-x)\,(r+x-2x)}$$

$$= \frac{2\,Vr}{(r-x)\,(r-x)} = \frac{2Vr}{(r-x^2)} \quad \ldots\ldots (1b).$$

This is the same as *Mandal's correction of Smythies modification.* (*vide* Indian Forester Vol. 73, No. 4, pp. 169 - 170).

THE DONA TECHNIQUE OF RAISING TEAK SEEDLINGS.

BY R.M. SINGHAL, M.SC., B.SC. (EDIN.),

A.C.F., MADHYA PRADESH.

In large scale planting programmes, it is necessary to raise large number of tree-seedlings in nurseries,. The success of the transplant in the field depends on their health and power of adoption to the change of environment. To provide for maximum ot success, the root system of the plant should be least disturbed while planting out and it is with this object that the *dona-method* was first started by Shri L.H. Lokre, instructor, Balaghat Forest School. The teak seedlings are transplanted into *donas* (leaf-cups) at a very early stage and while planting out the whole *dona* is placed in the pit ; thus the roots are not disturbed.

Teak seed is collected from selected trees and it is spread on bamboo-mats on a raised

G.S.=Growing Stock.

platform and left to weather from July to October. The outer soft covering of the seed rots away and the hard black endocarp is exposed. It is then stored in a dry place during the winter and then sown in next June.

Seed beds—A 30'×4'×2½' pit is dug and the bed is prepared as follows:

I layer —	loose earth —	1 foot
II layer —	sand —	6 inches
III layer —	earth —	6 inches
IV layer —	sand —	6 inches
V layer —	top layer of forest-soil and litter	9 inches

The soil used for making beds is sandy loam which is freed from large pieces of rock and stones.

Sowing—The litter is burnt and the ash mixed up with the top layer of the soil. 20 seers of weathered seed is then spread evenly over the bed and covered with a layer of soil half inch thick and a thin layer of cut grass to prevent washing away of top-soil during watering. The beds are covered with bamboo mats to save excessive evaporation of water, till the germination begins. The beds are watered twice a day; germination—starts within 8 to 10 days.

Cover—When germination is noticed, the bamboo mats are removed and the cover is raised about a foot from the level of the bed to allow light and air circulation and at the same time to shade the tender seedlings.

Transplanting in donas.—The seedlings grow for 8 to 10 days in the beds when they are big enough to be transplanted in *donas*. *Donas* are made from the leaves of *mohawa* (*Bassia latifolia*) *palas* (*Butea frondosa*), or *tendu* (*Diopyros tupru*). Each *dona* is about 5 inches in diameter and 7 inches deep and has a perforated bottom. The *donas* are filled with moist top layer of forest soil free from large stones. Seedlings 1½ to 3 inches in height are most suitable for transplanting. I have observed that seedlings which are just developing secondary roots from the radicle survive better than those which have already developed their root system. Care is taken to pack the soil round the seedling to facilitate adhesion of soil particles to the root.

The *donas* are put on bamboo platforms 1½ feet from the ground and kept covered from 10 A.M. to 4 P.M. with a thin mash of bamboo. The covering is 10 feet above the ground (see Photograph). The plants are watered every morning and evening by a fine spray.

The plants in the *donas* grow for 2 to 4 weeks and are about 3 inches high, and with six to eight pairs of leaves. After a good rain, they are taken to the forest and put in pits and left to grow.

The cost of raising seedlings in *donas* is about Rs. 3/- per hundred as against Rs. 1/12/0 per hundred for root and shoot cuttings. Moreover *dona* seedlings are capable of withstanding drought for a longer period, before the seedlings are well established on the ground, than root and shoot cutings.

This technique may be successfully used for other species whose seedlings are more delicate and suffer greater mortality than teak such as *bija* (*Pterocarpus marsupium*), *sewan* (*Gmelina arborea*), *haldu* (*Adina cordifolia*) etc.

ANGIOSPERMIC PARASITES OF OUR FORESTS

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SUMMARY: Parasites are plants which depend on other plants (called 'Hosts') for their total or partial requirements of food. Many flowering plants, besides a large number of Cryptogams, are known to exist as parasites and do considerable damage to our garden and forest plants. **Loranthus** *is one such, and a number of species of this parasite are known to attack many of our fruit and timber trees, including teak, sal, oak, gumbhar, Wattles etc. It has been noticed that a particular species of* **Loranthus** *attacks a particular plant, though this preferential treatment has not yet been established. Much more elaborate work on these lines requires to be done.*

No proper control and eradication methods of **Loranthus** *are as yet known, except that of cutting the affected branch below the point of infection and burning it completely. Biological or any other method of control has not been tried (as in the case of* **Lantana**, *for example), though the problem has assumed considerable importance and requires more attention than paid to it at present. Many plantations raised at great cost had to be abondoned and written off due to its severe attack, as for example, the Gmelina plantations in Bengal and Burma and the Wattle plantations of South India.*

Reliable data of the expenditure incurred in the eradication of **Loranthus** *by the cutting and burning method are not available.*

Introduction: Plants are known to be the primary "kitchens" and the "laboratories" of the world. The green pigment—chlorophyll —found in the leaves of the plants synthesises the food of all living beings, including man. But there are the "lazies" and the "thieves" among plants as well. The "struggle for existence" and the "survival of the fittest" makes it imperative for such "weaklings" to seek the help of others. These grow on other plants and thus try to secure maximum amount of sunlight and air for themselves. Yet another problem, the supply of raw materials, comes into the picture at this stage. Some keep contact with the earth for the same reason, and therefore have to produce a very long stem, though weak. Others grow on "host" trees at the expense of the contact with the earth and have to be content with the moisture of the air or the sap of the hosts. Thus climbers, epiphytes and parasites came into existence. It is against these that we have to guard our important plants very often, for our own sake.

Parasites are plants which derive their nourishment from other plants. Some of them like *Cuscuta* L., *Cassytha* L., *Balanophora* Forst., *Orobanche* L., *Christisonia* Gardn., *Rafflesia* R. Br., etc. are dependent entirely on the host plants for their food and hence are known as "Total Parasites." Others like *Loranthus* L., *Viscum* L., and other Loranthaceae, *Santalum* L., *Striga* Lour., *Pedicularis* L., *Myzodendron* Soland., *Rhinanthus* L., *Thesium* L., *Melampyrum* L., *Tozzia* L., *Euphrasia* L., *Bartsia* L., etc. can meet some of their requirements of food with the help of their green leaves, and therefore are known as " Semi—" or " Partial Parasites ".

Plants belonging to either of the groups can have their connection with the stem or the root of the host plant. Those which have their conductive tissues connected with those of the stem of the host through their root suckers or haustoria are called "Stem Parasites". *Cuscuta* L., *Cassytha* L., *Viscum* L., *Loranthus* L., are some of the known stem parasites, and are economically important from the foresters' point of view. A number of plants maintain connections with the roots of the hosts and are called "Root Parasites", the most common examples being many species of Scrophulariaceae which attack the roots of grasses in marshy areas. *Rafflesia* R. Br. is another example of interest, since it produces the biggest known flowers in the world, while its vegetative organs are reduced to something like the mycelium of a fungus, which spread in the tissues of the host. The following are some of the examples of root parasites:

Santalum L., *Orobanche* L., *Balanophora* Forst., *Rafflesia* R. Br., *Striga* Lour., *Pedicularis* L., *Scybalium* Schott., *Langsdorffia* Mart., *Hydnora* Thumb., *Lathraea* L., *Pholisma* Nutt., *Ammobroma* Torr., and other Lennoaceae, *Thesium* L., *Melampyrum* L., *Pozzia* L., *Euphrasia* L., *Bartsia* L., *Rhinanthus* L. and other Scrophulariaceae. Probably the most important and known the world over, is the root parasite *Santalum album* L. of South India.

The habit of parasitism is not confined to the angiosperms. Many fungi and bacteria are known to exhibit this characteristic, causing, in many cases, considerable damage to the hosts. Many diseases of animals and plants are the direct result of their attack.

Loranthaceous Parasites: Our forest trees are generally attacked by parasites belonging to the family Loranthaceae. Lushington (18) has found the following five genera of this family to be common in the forests of South India:

(1) *Loranthus* L. (59 species)

(2) *Viscum* L. (12 species)

(3) *Arceuthobium* Rich.

(4) *Notothixos* Oliv.

(5) *Ginalloa* Korth.

The Loranthaceae may be identified by the following distinguishing characters as stated by Mozelle Isaac (19).

(i) Habit: Semi- or total parasites, rarely rooted to the ground.

(ii) Receptacle: Cup shaped.

(iii) Ovary: Inferior, monocarpellary and unilocular.

(iv) Fruits: One seeded berries, the seeds adherent to the pericarp throughout.

Lushington rightly points out that in almost all forests where the vegetation has been damaged by fires, Loranthaceae abound; and, once they become established they spread with great rapidity. It is not uncommon, therefore, to find forests ruined by these parasites. The vegetation, weakened by fires, becomes almost totally incapable of battling against the members of the Loranthaceae; the more valuable species are usually the first to be killed out. Lushington further emphasises the necessity of a thorough and systematic study of these pests from the foresters' point of view, so that we can easily identify them and evolve suitable eradication and control methods, which are at present either unknown or ineffective and expensive. All the botanical books classify them according to their floral characters. It is generally not possible and practicable for a forest officer in India, burdened with a huge territorial charge, to visit all the localities of their ravage at a time when all or any of them are in flowers. Brand (3) suggests that the best time to visit a plantation or a forest for this purpose is when the trees are leafless, especially in old teak plantations. Lushington, therefore, concludes that it is advantageous to work out some other method, not based on floral characters, to distinguish them from one another. He has devised a classification of the Loranthaceae based upon parts of plants which are always available (stem, leaves etc.) and can be examined at the time of inspection. In the following table a gist of his classification of Loranthaceae is given and such of those who are interested in further details may refer to his article. (18) Loranthaceae:

I. Plants NOT di-or trichotomously branched :

(A) Leaves opposite, sub-opposite, opposite and alternate or alternate.........*Loranthus* (except *L. elasticus* (Desr.).

II. Plants di-or trichotomously branched; leaves entirely opposite, reduced to scales or absent :

(A) Leafless parasites :

(a) Stem O, but with an inconspicuous stock which ramifies within the bark which the minute branches perforate but scarcely rise above the surface..............*Arceuthobium.*

(b) Bushes appearing prominently above the surface of the bark...........*Viscum.* (4 species)

(B) Leafy parasites :

(a) Hoary or tomentose shrubs........ *Notothixos.*

(b) Glabrous shrubs :

(1) Very slender shrubs, with a sheath-like thickening at the base of branches......*Ginalloa.*

(2) Shrubs without sheath-like thickening at the base of branches :

(i) Branches sparsely lenticelled, fruits red ......*Loranthus elasticus.*

(ii) Branches not lenticelled, fruits not red *Viscum.* (8 sps.)

All the species of *Loranthus* do corsideuable damage to forest trees. Perhaps the most noticeable case of injury is that done to the the exotic *Acacias* planted as fuel trees in the Nilgiris. Dr. Bidie (I) gives in detail, the destruction caused by this parasite on the Australian *Acacias*. He reports that the rough-barked *Acacia melanoxylon* R. Br. (Black Wattle or the Australian Black Wood) has suffered to a much greater extent than the smooth-barked *Acacia dealbata* Link. (The white or Silver Wattle). The failure of *Gmelin aarborea* Roxb. (*gumbhar*

or the 'Bengal Teak') plantations due to *Loranthus* is well known. Brand says that it is not uncommon to see one or the other species of *Loranthus* on *Tectona grandis* L. (Teak or *sagwan*) and *Terminalia tomentosa* W. & A. (*nallamadi* or *ain* tree) in the Nilambur division. The attack is very severe in old teak plantations, the species most common being *L. longiflorus* var. *falcata*. Kurz. The forests of Hyderabad state are also most infested by species of *Loranthus*. Therefore we shall confine ourselves to the study of *Loranthus* in this article.

Loranthus : - The genus *Loranthus* belongs to the family Loranthaceae of the order Santalales. It is the largest and the most important genus of this family with about 250 species. Many of the species are inhabitants of the tropics in the Old World, but some species are also found in the temperate zone e.g. L. *europaeus* on *Quercus* L sp. (Oaks) and *Castanea vulgaris* Lam. (Chestnuts) on the continent of Europe.

Loranthus is commonly known as " *Kharazdar*" meaning a debtor a connotation to its parasitic habit. True to its name, all the members of this genus are semi-parasites and grown on the branches of host plants by means of haustoria or suckers. Where the parasitic root joins the host, there is, not uncommonly, an outgrowth, often of considerable size and complicated shape. In addition to the nourishment they obtain from the host plant, their green leaves also meet partially their requirements of food.

Brotanical Description

Leaves opposite or alternate. (In some, both the conditions are found on one and the same plant.) fairly thick, slightly fleshy, large and green ; shape varies from place to place and species to species.

Flowers big, showy and conspicuous. Axis develops a small outgrowth known as calyculus. A concave bract develops from the base of the flower and is adnate to the perianth. Likewise the ovary is also adnate [illegible] which consists of 4 [illegible] members. Sta[illegible] perianth. Anth[illegible]

Pollination is [illegible] by insects or small birds which visit [illegible]e flowers for nectar. A nectar gland is [illegible]nd at the base of the perianth or the [illegible]ie.

Fruit a one seeded berry.

Dispersal of seed. The pulp of the berries is very viscid and the seeds are very hard. Birds are fond of the fruits. Cliford (5) remarks that the distribution of seeds is mostly by birds, the chief distributor being species of *Dicaeum*. Birds eat the outer pulp and the seeds stick to their beaks because of the pulp. They have to rub their beaks against branches to wipe off the seeds. Seeds may also be swallowed and very often pass uninjured through the alimentary canal and deposited in the excreta. They are thus transferred to branches where they germinate under favourable conditions.

Germination of seed. Germination commences after some time. First of all the hypocotyl grows making a curve, and ultimately fixes the seed to the branch with its sucker-like tip. From the centre of this sucker develop many haustoria, pass through the bark of the host plant and connect themselves with the conductive tissues of the host. Finally the plumule also develops.

Parasitism . As it is commonly known, *Loranthus* grows as a parasite on other plants, from which it derives its nourishment. Cases of " Uni-parasitism " are very common and numerous. In some cases " Double-parasitism" has also been noticed, in which *Loranthus*, at one and the same time, serves as a host for some other species while it is itself a parasite on another plant. Morris has noticed *L. pendulus* or *L. quandong* on *L. exocarpic*. Very recently Narayan Rao (20 has reported cases of " double-parasitism " from Bangalore, where *Shorea talura* Roxb. occurs gregariously on a large scale on a particular tract of the State and on which lac insects are reared. *Loranthus* is a severe pest on *Shorea*, which are generally attacked by *L. longiflorus* Desr. *Viscum ramosissimum* Wall. grows on *L. longiflorus*. Sri Narayan Rao has also observed " Triple-parasitism " in some cases. According to him some species of *Viscum* parasitise on other species of *Viscum* growing on *Loranthus* which itself is a parasite on some tree.

Species of Loranthus and Their Hosts : Many species of *Loranthus* are found in India. Hooker (14) and also Lushington have described no less than 59 species. Fischer (8) has also noted a number of species from South India. The Bombay Dept. of Agriculture (2) lists 29 hosts of this parasite (*L. longiflorus*.), of which 13 are fruit trees, *Mangifera indica* L. (Mango) being frequently seriously damaged. Brand (3) says that

L. longiflorus var. *falcata* Kurz. is the main species attacking at least 110 tree species, including teak, *Acacias*, *Albizzias* and *Melias*, in Madras (though he has not given any list of plants). Troup (25) records the attack of this parasite on *Shorea robusta* Gaertn. f. (Sal) in Bihar and Orissa and *Pinus longifolia* Roxb. (chir pine). Reports from Ootacamund are that species of rose and wattle are infested with it. Gamble (II & 10) while describing a number of species, records the following species attacking commercially important timber trees :

(I) **L. Wallichianus** Schultz. : Attacks Australian *Acacias*, *Helicteres L.* and *Memecylon* L. and other indegenous trees in the Nilgiris, Western Ghats and other hills of South India.

(2) **L. tomentosus** Heyne. (3) **L. neelgherrensis** W. & A. (4) **L. memecylifolius** W. & A.	On introduced Acacias, and various other trees specially in the *sholas* and Nilgiris at higher elevation. On *Neolitsea Zeylanica* in Coorg.

(5) **L. elasticus** Desr. : On many trees as the mango, orange, nutmeg, *Samadara*, Gaertn., *Thespesia* Corr., *Euphorbia tortillis* Rottle., *E. antiquorum* L., etc. on Nilgiris, at lower elevations.

(6) **L. loniceroides** L. (7) **L. capitellatus** W. & A.	On Australian *Acacias* on the hills of South India.

(8) **L. hookerianus** W. & A. : *On Mallotus philippinensis* Muell.

(9) **L. intermedius** Wight., : Often on *Cinnamomum wightii* Meissn. and *Machilus macrantha* Nees. in the Nilgiri *sholas* between 3000′ = 6000′.

(10) **L. obtusatus** Wall. : In the Western Ghats, Nilgiris and the Pulney hills (over 5000 ft.) on *Rhododendron* L., *Symplocos* L., *Daphniphyllum* Blume., and other *shola* trees and on *Acacia melanoxylon* R. Br. in plantations.

(11) **L. recurvus** Wall. : On *Viburnum* L., and *Glochidion* in the Nilgiri *sholas.*

(12) *L. trigonus* W. & A. : On the banyan fig and other trees.

(13) **L. lageniferus** Wt., Ic. : In deciduous forest on *Holarrhena* R. Br., and *Adina* Salisb. etc.

L. memecylifolius has also been observed on many *shola* trees as *Rhododendron, Rapanea, Daphniphyllum,* etc.

P.F. Fyson (9) has recorded 13 species on Nilgiris and the Pulney hills. He describes *cuneatus* Heyne. as usually attacking *Dondonaea viscosa* L.

Work on such an exhaustive scale has not been done in North India, though some data is available. Haines (13) has recorded the following four species :

(1) **L. longiflorus.** Desr.
(2) **L. scurrula.** L.
(3) **L. globosus.** Roxb.
(4) **L. cordifolius.** Wall.

R.C. Lacy (17) has confirmed this view. According to him' *L. longiflorus* is very common on *Magifera indica* (Mango) and *Dalbergia latifolia* Roxb. (Rosewood) in and around Patna. He also reports that its attack is intense on *Aegle marmelos* Correa. (Bel) and *Terminalia catappa* L. (Wild Almond) in Calcutta. Similarly Gamble (II) records the following species in North India :

(1) **L. longiflorus** Desv.	In oudh on........	**Bassia** L. (Mohwa) **Buchanania** Roxb. (Piyal) **Diospyros** L.
	in U.P. on........	**Melia** L. **Bauhinia** L. [illegible] **Albizzia** Du[illegible] **Mallotus** [illegible] **Mangife**[illegible] (Mango) **Prunus p**[illegible] (Peach) **Pyr**[illegible] (Pear)
	in N.W. Himalayas upto 6,000 ft. (Simla)	**Quercus dilatata** Lindl. Moru Oak)
	in Sikkim on........	**Shorea robusta** Gaertn. (Sal) **Albizzia** Durazz.

The *Donas* are placed on bamboo platforms about 1½ ft. high.

Photo—Author

		In Sunderbans on....	**Heritiera minor** *Sundri*) and other trees.
(2)	**L. odoratus** Wall.	In Eastern Himalayas and Khasi Hills........	**Quercus** sp. (Oaks)
(3)	**L. pentapetalous** Roxb.	In E. Himalayas, Assam and E. Bengal, and in Darjeeling,(W. Bengal)	**Quercus** sp. **Acer** Tour. (Maples) **Castanea** Tour. (Chestnuts) and other trees.
(4)	**L. ligustrinus** Wall. (a terrestrial or root-parasite). (Banda)	Himalayan and sub-Himalayan regions on	**Albizzias** Olives (*Olea* sp.) and Laurels.
(5)	**L. pulverulentus** Wall. (Parand)	on........	**Butea frondosa** Koenig. (*palas*) and other trees of the deciduous forests.
(6)	**L. vestitus** Wall. (Pand)	In Western Himalayas, up to 7000 ft. specially Khasi Hills.	**Quercus incana** Roxb. (Ban Oak) **Q. dilatata** Lindl. (Moru Oak) **Schleichera** (Willd. (*Kusum*) **Randia** L. (Mainphal) **Machilus** Nees. **Odina wodier** Roxb. (*gumpana*)

Cooke (6) has recorded about a dozen species from Bombay State and remarks that the following plants serve as hosts to various species of *Loranthus.*:

Memecylon edule Roxb. in Karwar for *L. Wallichianus* Schult. ; *Xylia dolabriformis* (The Pyinkado or the Iron-wood tree of Burma) and *Myristica attenuata* Wall. for *L. obtusatus.*; *Leea sambucina* Willd., *Dillenia pentagyna* Roxb., and *Pterocarpus marsupium* Roxb. (Bijasal or Gum-kino tree) in Kanara for *L. Scurrula* L.; *Phyllanthus emblica* L. (Aonla) near Gersoppa falls for *L. gibbosus* Tal.; Mango for *L. elasticus, Terminalia paniculata* W. & A. (Kindal) for *L. cuneatus* Heyne.; *Flacourtia montana* Grah. for *L. longiflorus* var. *amplexifolia* Thwaites. ; *Flacourtia, Chloroxylon* DC., and *Garcinia* L. for *L.* 1. var *pubescens* Hook.; *Careya arborea* L. (Kumbait ree) and *Terminalia belerica* Roxb. (Beleric myrobalam) for varieties *falcata* and *coccinia* Talbot. of *L. longiflorus*. *Eugenia jambolana* Lam. (*Jaman*). *Ficus glomerata* Roxb., *F. mysorensis* Heyne., *Dalbergia latifolia* Roxb. and *Zizyphus xylopyrus* Willd. are attacked by *L. trigonus* Wight. & A. whereas *Adina cordifolia* Hook. (*haldu*) and *Artocarpus integrifolia* L. (Jack tree) are attacked by *L. lageniferus* W. & A. and *L. capitellatus* W. & A. respectively.

Partridge (21) has observed only two species of *Loranthus* in the forests of Hyderabad (rather doubtful), which are :

(1) **L. longiflorus** Desr.

(2) **L. scurrula** Roxb.

L. longiflorus, according to him, is very common in Hyderabad and has been found to attack many of the forest species. *L. scurrula* Roxb. is less common, though equally destructive. Partridge has noticed *L. longiflorus* to be very common on *Bassia latifolia* (*mohwa*) and *Diospyros melanoxylon* Roxb. (*abnus* or *tendu*). Troup also says that *L. longiflorus* does much damage to mango tree and is probably the chief species responsible for the extensive injury done to *mohwa* tree in the Indian Peninsula, where it is the cause of much mortality.

Prof. M. Sayeedud Din (22 & 23) of the Osmania University has worked on the angiospermic parasites of the state. He has observed *Loranthus* on many of the important plants of Hyderabad. He remarks that if this, pest is not controlled and eradicated in time considerable damage may be caused. He has noticed severe attack of this parasite on *Achra*

sapota L. (the "Sapodilla" tree of the West indies) and *Eugenia jambos* L. (Rose apple), two garden plants important for their fruits.

The following is the list of plants on which Prof. Sayeedud Din has noticed the parasite in the gardens and forests of Hydrabad State :

(1) **Anona squamosa** L. (Custard apple)
(2) **Citrus aurantium** L (Orange)
(3) **Psidium guyava** Raddi. (Guava)
(4) **Punica granatum** L. (Pomegranate)
(5) **Achras sapota** L. (Sapota)
(6) **Morus indica** L. (Mulberry)
(7) **Mangifera indica** l. (Mango)
(8) **Eugenia jambos** L. (Roseapple)
(9) **Azadirachta indica** A. Juss. (*neem*)
(10) **Tamarindus indica** L. (Tamarind)
(11) **Terminalia catappa** L. (The Indian or Wild Almond)
(12) **Mellingtonia hortensis,** L. (Indian Cork Tree).
(13) **Murraya koenigii** Spreng. (Curry leaf plant).
(14) **Calotropis gigantea** R. Br. (*Safed Aak*).
(15) **Sapindus laurifolius** L. (Soap nut tree or *ritha*)
(16) **Dalbergia sissoo** Roxb. (Sissoo or *shisham*)
(17) **Eriodendron anfractuosum** DC. (the Silk cotton tree)
(18) **Diospyros melanoxylon** Roxb. (*abnus* or *tendu*)
(19) **Cordia myxa** L. (The Sebesten Plum or *gondni*)
(20) **Acacia concinna** DC. (*shigakai*)

R. C. Lacy has also published a similar list of hosts of *Loranthus*. On many of these plants he has himself noticed the parasite in and around Patna. Besides those which have already been included in the above list, Lacy's list comprises the following plants :

(1) **Codiaeum variegatum** Blume. (The garden Croton)
(2) **Rosa** sp. (Rose)
(3) **Callistemon linearis** (Bottle-brush)
(4) **Sesbania aegyptiaca** Pers. (*janjhan* or *ravasingh*)
(5) **Bauhinia variegata** L. (*Kachnar*)
(6) **Cassia auriculata** L. (*tarwar*)
(7) **Casuarina equisetifolia** Forest. (The Beef Wood of Australia)
(8) **Thevetia neriifolium** Juss. (The Yellow Oleander)
(9) **Mangifera indica** L. (Mango)
(10) **Bombax malabaricum** DC. (*semul*)
(11) **Cassia Fistula** L. (The Indian Laburnum or *amaltas*)
(12) **Aibizzia lebbek** Benth. (Black Siris)
(13) **Pongamia glabra** Vent. (The Indian Beech tree or *karanj*)
(14) **Ficus infectoria** Roxb. (Wild Fig or *jungli-pipli*)
(15) **F. religiosa** L. (Peepal)
(16) **Aegle marmelos** Correa. (*bel*)
(17) **Swietenia macrophylla** King. (Mahogany)
(18) **Cedrela toona** Roxb. (Toon or Red Cedar)
(19) **Melia azedarach** L. (Persian Lilac or Bastard Cedar or Bead tree.)
(20) **Wrightia tomentosa** Roem. & Sch. (*Kala inderju* or *dudhi*)
(21) **Premma nucronata** Roxb. (*Kala bogoti*)
(22) **Tectona grandis** L. (teak or *sagwan*)
(23) **Grevillea robusta** A. Cunn. (Silk Oak)

Many of the plants enumerated above are found in the forests of Hyderabad state. As yet there are no records available whether these plants are also attacked or are susceptible to the attack of these destructive parasites. It is in the interest of the Forest Department of the State and the country at large, to institute research in this direction. From the study of the data given above it looks as if various species of *Loranthus* have some sort of selective habit, and will generally be found only on particular hosts. It is unfortunate that many of their hosts are either good timber species or are important for other reasons.

Control Methods: Nature has provided certain plants with the power to resist the attack of parasites. Some plants appear to be immune from parasitic attack, possibly through the secretion of toxins, or of substances which induce apo-chemotropic reactions in haustoria or through the absence of substances which induce pro-chemotropic reactions (like glucose in case of *Cuscuta*). (17) It has been noticed that when pear is attacked by the mistletoe (*Viscum*), the infected branches die, whereupon the mistletoe also dies ; thus pear is generally free from parasites. Some trees are immune to parasitic attack through the impenetrability of the cork layers ; and sometimes infected regions of host plants are isolated by the formation of cork.

But there are many plants which are susceptible to their attack. No effective measures

have yet been evolved to control or check their attack in the forest. Even in orchards their eradication is difficult once they establish themselves, though it is fairly easy to prevent them from establishing themselves (Hayes 12). If occasional attacks are promptly dealt with, the damage done is small. The only remedy so far known is to lop off or cut the infested branch and burn it. Where the hosts are deciduous trees, this can best be done when they are leafless, the evergreen parasite showing up conspicuously. In fact this practice was adopted as far back as 1867, when this pest was first noticed in Nilambur, Madras. The operation was carried out spasmodically at intervals at first, but it is now being done regularly along with the thinning operations, since the Working Plans prescribe it for the years in which thinning is done. Coolies are sent up the trees to cut off the infested branches, which are collected, piled and burnt. In 1905, Lushington prescribed that these branches should be stacked and measured, prior to burning, as a check on the coolie's work. Considering the difficulty in carrying out the operation over extensive areas, it is no wonder that it was not a complete success.

Brand (3) has suggested the following method for the eradication of this pest. He says that the branches of all the species on which the parasite is growing should be cut (when teak is leafless in the plantations) before the fruits of the parasite ripen (which is from March to June). Cutting should be done in January-February. The branches should be cut in such a manner that the whole of the parasite, including the very tips of the oppressed rootlets, is removed. Even if a tip is left behind it may grow into another bush, and therefore it is not sufficient merely to pull the parasite off the branch. It is important that the parasite should also be removed away from the patches of miscellaneous forest included within or near about the plantations or orchards, as these would otherwise provide the seeds for fresh infection. Brand further gives a plan of work for teak plantations in Nilambur. He prescribes that in plantations which have not had their final thinning, *Loranthus* removal should be carried out after each thinning. After the final thinning the operation should be repeated every five years until the date of final felling.

The operation suggested is difficult, elaborate and fairly expensive, and has also no absolute guarantee of success. Yet it had been practised in many places with a fair success. No data are available of the exact expenditure involved in the operation. In Nilambur division, Madras, it was found that the cost of climber cutting and removal of *Loranthus* varies from Re. 0-7-3 per acre in the more accessible plantations of Nilambur range, to Re. 1-4-0 per acre in the remote parts of Amarampalam range.

It is unfortunate that this problem has not received the attention it deserves. No proper research or investigation have been carried out so far, nor other methods of control (such as biological control) tried. It is earnestly hoped that this problem will be tackled in the near future.

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INTRODUCTION OF BAMBOOS THROUGH AFFORESTATION MEASURES.

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Introduction. The importance and utility of bamboos as a pioneer or auxiliary species under afforestation schemes appears to have received scant attention so far, presumably due to the difficulty of introducing the species in ordinary times when the usual method of propagation is by rhizomes which at best is both costly and laborious. However, with the impending flowering of bamboos in the forests of North Kanara where *Dendrocalamus strictus* has already started flowering gregariously in some tracts, ample supplies of seed would be available during the next few years and there is no reason why bamboos should not be re-introduced in localities where it once thrived and whence it has been displaced through disforestation.

Localities in which Bamboo may be introduced. A lengthy survey or investigation is not necessary to determine localities suitable for the re-introduction of bamboos as solitary clumps that are frequently met with provided adequate evidence of the fact that the bamboos flourished in those regions and bear mute but eloquent testimony to the hardy nature of this species. A close study of the vegetation as one proceeds from Dharwar and Hubli to Dandeli and Yellapur respectively reveals that bamboo is gradually receding into the interior and less populated parts and that the areas divested of bamboo growth are fast deteriorating in soil fertility and getting infested with lantana bushes. This observation forcibly directs one's attention to the important role bamboo plays in the ecological development of forest growth and the maintenance of the fertility of forest soils. The regulated reintroduction of bamboos under afforestation measures would, it is felt, materially assist in the successful accomplishment of such measures not only through the benefits of its ecological association but also through the direct protection the bamboo growth can offer to the tree species introduced under afforestation measures.

Advantages of raising bamboos. The introduction of bamboos through afforestation measures is advocated on the following grounds :—

1. Bamboo is easy to introduce with seed which, being small in size and availabe in plenty due to the gregarious flowering, will be cheap.

2. No special preparation of the soil prior to sowing is essential and so the cost of introduction is kept low.

3. Protection from fire and grazing is required for a period of two years only during which period the plants develop rhizomes. However, to produce a healthy crop, cutting needs to be prohibited for a period of 8 to 10 years depending upon the locality and soil factors.

4. The thorny nature of the plant makes it least liable to damage by grazing, and grass which would normally be available in plenty in the areas taken up is preferred by animals.

5. The bamboo crop does not require any tending whatsoever.

6. The bamboo growth does not interfere with the introduction of other species under afforestation measures.

7. The bamboo growth will afford protection to the tree species either introduced or naturally coming up. [Very often bamboo is a menace to the regeneration of tree species—Ed.]

8. The bamboo crop covers up the area to be afforested satisfactorily within the shortest period.

9. The bamboo crop begins to yield material useful to the agriculturist and the local population in more than one way much earlier than any other species can.

10. Grown in fair density the bamboc crop will restrict the spread of *Lantana* which is a pest to the agriculturist and the forests alike and finally eradicate it.

11. The extension of bamboo bearing areas will be an asset to the prospective pulp and paper industries.

Seeding of bamboos and need for preliminary work. The gregarious flowering of "*Dendrocalamus strictus*" (*medar*) commenced only two years ago and will continue for another

3 or 4 years, and *Bambusa arundinacea* (*dowga*) is expected to flower within the next 8 to 10 years. Seeds of the former species will be, therefore available for 4 to 5 years more and that of the latter species will be available after about 8 to 10 years; and seed of the species can be stored for over one year in air-tight containers. Hence it is suggested that a trial in the introduction of bamboos may be taken in-hand immediately with the aim of collecting accurate and reliable data regarding the cheapest and best method of raising bamboos.

Where introduction of bamboos is necessary. The localities in which the introduction of bamboos and consequently also the trial can best be undertaken are those from which bamboo has been or is being ousted and includes areas within the zone of the minimum annual rainfall required. Suitable plots can be selected in: (a) forest areas in charge of the Forest Department, (b) forest areas in charge of the Revenue Department, (c) Revenue waste fit for afforestation, (d) *gairans* or *gurucharans* and, (e) private owned forest lands.

In forest areas in charge of the Forest Department the trial can be carried out in coupes exploited during the current year especially in the teak pole forest of Haliyal and Mundgod ranges where bamboos are fast disappearing and lantana is spreadng at an alarming pace. In other areas suitable demonstration plots can be opened and bamboo introduced under adequate supervision and these will give sufficient indication regarding the method of introducing the bamboo on a large scale. The need for afforestation with bamboos as an auxiliary species has to be impressed by the Forest Department on the other Departments concerned and the private forest owners. Legislation to take over the control of private owned forest will make matters easier.

Special mention has to be made of the large extent of the *betta* lands—strips of forest lands set apart for lopping the trees for the leaf-manure required for betelnut gardens which have largely deteriorated to such an extent as to be useless for this purpose. Such deteriorated lands should be reserved as "Village Forests" and taken up for the introduction of bamboos, particularly of *chiva* (*Oxytenanthera monostigma*) which appears to be suitable for such lands.

Method of introduction of bamboos. The collection of seed has to be carried out under strict departmental supervision so that real seed alone is collected and not seed and husk together as one bag of the so-called seed (seed and husk) may eventually yield only 1/8th bag of the real seed. No special treatment of the seed pior to sowing is necessary, and it can be sown broadcast under bushes and shrubs care being taken to see that the seed reaches the soil. In current coupes it may be sown near the stools of the trees felled and along the border of *rabs*; and along with the *rab* work a few patches 6"×6" or 12"×12" and 25 feet apart may be made in the open and bamboo seeds sown in them. Trial broadcasting in the open may also be carried out but special care must be taken to see that the seed reaches the soil.

The period of sowing will depend on the rainfall conditions of the locality but, in general the sowing should be carried out just before the rains and completed by the end of June in all localities. However, the best time for sowing needs to be determined by experiment before operations on a mass scale are undertaken. In this respect, some experiments may be undertaken to see whether bamboo seedlings respond to transplanting as satisfactorily as those of *nachana*, a food grain of Kanara. The *nachana* seedlings when about 6" high are simply thrown on bare ground and all the seedlings take root and establish without exception, provided that the seedlings are thrown on bare soil (scraped or ploughed) and there is an almost continuous drizzle of rain for about a week after the operation.

General recommendations. Once the idea of introducing bamboos in localities from which it has been ousted is accepted, the preliminary trials can at once be undertaken and from the experience gained from these trials a five year plan can be drawn up in consultation with the other forest circles, and revenue divisions of this State. The possibility of taking up the introduction of bamboos through "Village Uplift Panchayats" or "Rural Development Boards" may also be explored, and *batta* lands may well be entrusted to such organizations.

The necessity of an immediate decision in the matter cannot be too strongly stressed as *Dendrocalamus strictus* is already in flower and if this opportunity is not now availed of, one has to wait for another 25 to 30 years *i.e.*, to the date of next flowering, for another such opportunity. It is hoped that the suggestions made in this note will receive due and mature consideration from the authorities concerned, and this opportunity will not be allowed to pass unutilized.

MORUS ALBA, Linn. (The common mulberry).

By K. Kadambi, Asst. Silviculturist, F.R.I.*

General habit and distribution.—

A deciduous tree of moderate size, attaining 30 to 40 ft. heights with girths of 3 to 6 ft., and a 4 to 10 ft. long, straight, more or less cylindrical bole. It is found in India in the sub-Himalayan tracts from Sikkim to Kashmir (Fig. 1.) and the Shan States of Burma, but is commonly cultivated in Afghanistan, Baluchistan, the northern part of the trans-Indus territory, in the plains of Punjab (Pakistan), Kashmir and the North-West Himalaya, Bengal and parts of the Decan tableland, notably on Mysore plateaux and the adjoining portions of Coimbatore district, Madras. This is the species of mulberry which, after its first experimental introduction into the Punjab (Pakistan) irrigated plantations, propagated itself naturally and became so aggressive as to necessitate the special protective cleaning operations to save *Dalbergia sissoo* from extermination ; as many as five cleanings were often required in the first $2\frac{1}{2}$ years before the sissoo was safe from mulberry. It is now well known that this mulberry was at first considered a dangerous weed but the suitability of its wood for sports goods soon proved it to be very valuable, and from its subordinate position as an unwanted weed it came to be looked upon as an important appendage to the sissoo crop.

The cultivation of mulberry extends from the plains to the Himalayas up to an elevation of 11,000 feet.

In Kashmir, systematic cultivation of mulberry commenced in the eighties of the last century, but probably its introduction into that State took place in Mughal times. Now it is a " Royal Tree " whose cutting, looping and the possession of whose wood is strictly regulated by law.

Local Names :—tutri, tuntri, tut, tunt-(Hindi) ; tut-(Punjabi); kambli-mara, kambli-haunu-(Kannada) ; posa—(Burma); mowon (Shan States); Labri—(Kachin) ; ngap-set-ting (Chindwin).

Botanical description :—

Tree; branchlets, petioles and leaves beneath pruberulous or pubescent. Leaves ovate or ovate cordate, acute, often lobed, toothed (dentate-Brandis), base 3-nerved, (base often cordate-Brandis). 2-3 in., rather membranous ; petiole $1\frac{1}{2}$—1 in. ; Flowers spicate, monoecious, the sexes often on distinct branches ; ♂ sepals eliptic, ♀ spikes ovoid, pedunculate, (outer sepals keeled, inner flat or concave—Hooker), styles short, free, fruit white or red, sweet.

Brandis says that the following species are closely allied if specifically distinct :—*Morus nigra*, Linn., cultivated in Baluchistan and known locally as *shah tut*, with broader, firm, thick 5-nerved leaves and purple fruit, and *M. atropurpurea*, Roxb., a native of China and cultivated in India, with cylindric 2 in. long, dark purple fruit.

There seems to be considerable amount of confusion as to the existing species and varieties of mulberry in India and this is not lessened by the confusion in the nomenclature of the species of *Morus* in the world. This need not concern us beyond what is necessary to get clear ideas as to the available mulberry plant varieties for forestry and sericulture. There are wild indigenous species, there are introduced species or varieties. Introductions have been made from Europe, from China and possibly from Japan or the Philippines, and there is a difficult problem for the botanist to clear up. The following is a summary that is without any botanical authority whatever :—

1. **Morus serrata** Roxb.—Giant Hill Mulberry. Hooker, Flora of British India, 4,000-9,000 feet in the Himalayas, Kashmir eastwards. (Probably one of the common Kashmir varieties).
2. **Morus laevigata** Wall.—Wild and Cultivated—Hooker, tropical and sub-tropical Himalayas to 4,000 feet. Assam, KhasiHills, Burma.
3. **Morus indica** Linn.—Hooker-China Japan. Temperate and sub-tropical Himalayas. Cultivated in Bengal.
4. **Morus atropurpurea** Roxb.—Hooker —China,—Introduced to India for fruit, cultivated. Probably the "*Shah-toot*".
5. **Morus alba** Linn. Hooker—North and West Asia. In India, cultivated to 10,000 feet. (Possibly in Kashmir but not certain).
6. **Morus multicaulis—Morus alba** var **latifolia**—Introduced to India from China or the Philippines about 1840; the so-called Phillipine Mulberry.

* " The excellent Punjab Forest Record, Vol. I, No. 2, by I. D. Mahendru has been freely used for collecting the information contained in this article."

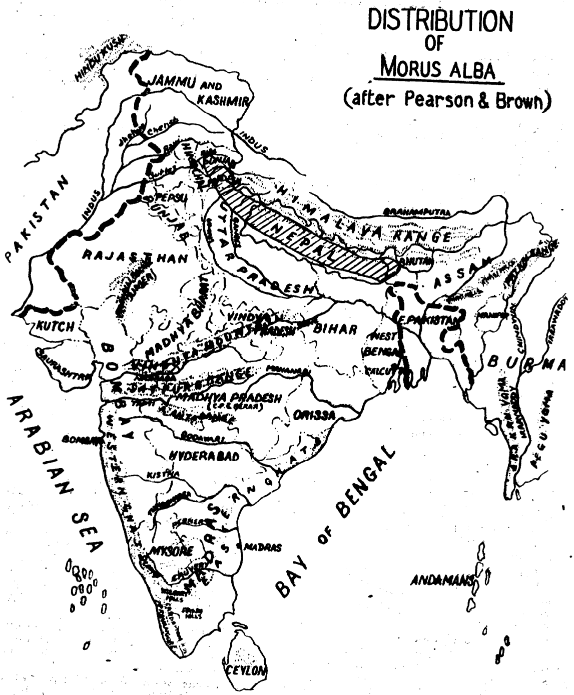

DISTRIBUTION
OF
MORUS ALBA
(after Pearson & Brown)
HINDU KUSH
JAMMU AND
KASHMIR
INDUS
PAKISTAN
PEPSU
RAJASTHAN
NEPAL
HIMALAYA RANGE
BRAHMAPUTRA
BHUTAN
ASSAM
UTTAR PRADESH
BIHAR
WEST
BENGAL
E. PAKISTAN
KUTCH
BOMBAY
MADHYA BHARAT
MADHYA PRADESH
ORISSA
HYDERABAD
BURMA
ARABIAN SEA
BAY OF BENGAL
MYSORE
MADRAS
ANDAMANS
CEYLON

Fig. 1

7. **Morus alba** var **rosea.**—Grows in Pusa.
8. **Morus alba** var **moretti.**—These are obtained as seed from France. The names are those used by the French seedsmen.
9. **Morus nigra** Linn. } are two varieties from France. The first is said to be cultivated in Baluchistan. (D.Brandis).
10. **Morus nigra** var **laciniata**
11. **Morus alba** var **sinensis.**—A variety from China. Possibly the variety in the Srinagar nursery.
12. **Morus japonica.**—A broad leaved variety, stated by l'Arbousset to have originated as a sprout among a lot of Japanese seedlings, in France.

The above are referred to in books, papers and silk literature; numbers 7 to 11 are of little value, and probably are not distinct.

From the silk point of view, there are the following :—

1. Indian or *deshi* bush mulberry. *Morus indica*—No. 3 above.
2. Bombay: Bush Mulberry of Bengal, *Morus*? A disinct bush mulberry to which two sources are ascribed; it may be the European variety brought to Bombay via. St. Helena in 1832. It may be any of the European varieties brought to Bengal through the European filatures.
3. Phillipine Mulberry No. 6 above. An early variety that grows well from cuttings.
4. Kashmir Mulberry— a tree, growing freely in Kashmir. This seems to be a distinct plant, with much indented leaf and a small black fruit; but what it is botanically is not clear. In Kashmir there is a white fruited plant, a black fruited, the *shah-toont*, a fruitless and a large leaved supposed Chinese race.
5. Japanese Mulberry (*Morus japonica*)— A tree or bush with very large leaves.
6. Italian, French, Hungarian Mulberries. Grown as trees usually. Probably varieties of *Morus alba*. A distinct form is Cleghorn variety, which bears no fruit and is a male plant, from a tree found in Ballyganj.
7. Mysore bush Mulberry.
8. The purple fruited Mulberry; *Morus atropurpurea* and perhaps also No.9 and 10. "*shah-toont*".

   The fruiting mulberry of Indian gardens usually regarded as useless for silkworm cultivation. Possibly the indigenous variety of Indore and Gwalior.
9. "Toont" or Fruiting Mulberry. Referred to my N.G. Mukerji as the best for fruit and called *Morus alba* var *laevigata*. Probably No. 2 above.
10. "*Kajli*" or "*Chini Toont*".—Referred to by Mukherji as *Morus alba* var *sinensis* and probably No. 11 above.
11. At Jeolkot, there is an unclassified variety that makes good bushes.

China is probably the original home of mulberry and it is found in a wild state in the northern and central districts. Mulberry is one of the most widely distributed species of the temperate regions of the old and the new world. In Asia it has been cultivated in China, Japan, India, Afghanistan and Persia. In Japan it grows wild in many parts, and attains large dimensions in the Ye forests. In Europe it is cultivated chiefly in the South. In Russia a very hardy variety of *Morus alba* is cultivated. It was introduced into U.S.A. in the last century.

Its cultivation in India goes back to antiquity. The *sukra-niti* mentions it as one of the chief species recommended under state patronage for cultivation near villages. At present it is grown extensively in the irrigated plantations of Punjab (Pakistan), and portions of Uttar Pradesh (where its introduction by the Forest Department was taken up at Clutterbuckganj), Mysore, portions of Madras, Bengal and Kashmir, etc.

Mulberry, which occurs in the W. Punjab in plantations of sissoo on islands, in the Jhelum and in such irrigated plantations as Changa Manga, are probably from seed carried down by the water or dropped by birds. Brandis referes to the Changa Manga species as *Morus alba*, Gamble referes to it as *Morus indica*. The mulberry gradually takes the place of sissoo and, in Changa Manga, the mulberry trees are extremely fine. These plantations are irrigated.

A question of the greatest impor[illegible]nce from the silk point of view is the behaviour of each variety as regards early budding. Mulberry becomes leafless in winter and as its buds and the leaves develop, the silkworm eggs are

brought on to higher temperatures so that as the trees come to leaf the worms hatch and find tender leaf for them. In India this is a matter of enormous importance in some tracts, as the earlier the trees will bud the earlier the worms can be hatched and the greater the chance of escaping the hot winds. Notably early varieties are the Phillippine, the European known as *Morus alba*, *vulgaris tenuifolia* and the unnamed variety of Jeolikot. The Indian bush (*Morus indica*) and the Himalayan *Morus laevigata* are late varieties.

Silvicultural Characters.

Its range of occurrence indicates that the trees can be raised under very varying conditions of soil and climate. It grows on sandy loam to heavy loam clay and, in nature, even on gravelly and rocky grounds. The important soil characteristics which influence its growth are soil texture, or the proportions of clay to silt contents, and depth. Deep soils containing some clay with abundant moisture present a favourable environment for the development of mulberry crops. Where sub-soil aeration is poor, with a Kankar substratum lying at no great depth below the surface, the development of mulberry is liable to suffer. Mulberry is a shallow rooted crop, but as it grows into a tree it tends to become deeper rooted and tree growth generally responds to depth.

The condition of the soil required for the growth of the tree is said to improve with successive rotations of the mulberry crop. In Changa Manga, at the end of 4 rotations the soil is said to have improved and also got modified in a way favourable to this tree. It is also stated that the special quality of timber required for sports material is not produced elsewhere even on rich soils, and this has been attributed to the fact that the quality of mulberry wood will improve with gradual modification of the soil in new plantations.

In the irrigated plantations of Punjab (Pakistan) it scores victory in its competition with sissoo owing to its relative shade bearing character, faster growth in its younger stages, greater coppicing vigour. It has proved useful as a soil protector and promoted cleaner and straighter boles in the sissoo.

The tree is an excellent coppicer and early seed producer. It also pollards well. It can be grown by seed—(in *taungyas*), planting root and shoot cutting (stumps) (Fig. 2) and also branch cuttings, though in the last case the plant percentage is decidedly lower.

The fruit generally ripens before the S.W. monsoon—May to June. Ripe fruit drops to the ground but is devoured before it drops by birds, usually sunbirds and starlings. The fruit can be harvested by shaking the branches. Unripe and incompletely developed fruit must be rejected. In Punjab the seed is extracted after drying the fruit, after which the seed can be beaten out with sticks. It can be collected by washing the fruit in water and drying in shade. Germinative capacity is low being 8 to 15 percent. The seeds are minute, 12,000 to 13,000 seeds (26,000 of *Morus alba* in Madras) weighing to the ounce.

In Uttar Pradesh germination has varied from 1 to 30 percent for fresh seed, and is 0% for one year old seed. Germination takes from 10 days to a month or more, but for all practical purposes it is complete in about 3 weeks. In Madras the plant per cent is 5, and 20,800 plants were obtained from 1 lb. of seed.

A good method of preservation is to stratify the seed in layers of fine dry sand or ashes. Seed baulked with fine ashes is said to remain good for 2 years in the Punjab, but generally speaking the seed does not store well and should be sown fresh.

The tree is capable of spreading naturally with ease. In Changa Manga its spread has been attributed mainly to water, also to the distribution of its seed by birds (starlings) and to a small extent by jackals and human beings.

The factors favourable for the natural regeneration of mulberry are:—

(a) suitable shade (Partial shade is preferable).

(b) soil free from heavy weed growth and excess of alkali salts.

(c) adequate soil moisture.

Shri Mahendru, has stated that in Punjab shade of some sort is beneficial for its establishment and growth during the early stages. It can be grown without shade in various parts of India, notably on the Deccan plateaux.

Suitable shade is only required in arid localities with high summer temperatures and this is not found necessary in localities with moderate elevation of say 2,000 ft. and fairly adequate rainfall of say about 30 inches. In

Fig. 2.

"*Morus alba* $2\frac{1}{2}$ months old plant raised from 2" long stumps having about $\frac{3}{4}$" long shoot and about $1\frac{1}{4}$" long root. D.A., New Forest, Dehra Dun."

Photo—M. Bakhshi—4-8-40

the very early stages, however, shade may be beneficial to the seedlings, but the advantage of shade is not perceptible after the seedling has established well and started going ahead.

In the *Taungyas* of Uttar Pradesh, mulberry has been found easy to raise and grows fast and bushy, and thus beats the browsing damage, and attains a height of $2\frac{1}{2}$ to 3 ft. in the first year. In Uttar Pradesh the species is considered eminently suitable as an undercrop, especially in *Tanugya* plantations, and will also succeed in the open wherever the soil is not too sandy or dry.

The chief trouble with the species in Uttar Pradesh is excessive branching. The raising of clear boles requires meticulously carried out pruning (M.D. Chaturvedi). It may be possible to find a race or a variety which is less branchy and attempts in this direction are probably worth making. Breeding a useful variety could also be thought of.

Experience in Changa Manga has indicated that in a 'coppice with standards' crop of mulberry and sissoo the former is not quite satisfactory as a standard as it is short lived and soon becomes hollow, and the standards also get over-branchy and hinder the progress of the coppice. In pure coppice crops the stems are not adequately wind-fast but this could probably be remedied to a great extent by keeping the crop adequately thinned from the beginning.

The tree is easily raised from seed, by seedlings with root and shoot cut, or vegetatively by planting branch cuttings.

In a dry locality irrigated line sowings are preferable. For transplanting purposes the seedlings are best reared in well raised, shaded beds, protected against drip. Budding of superior varieties of cultivated mulberry to ordinary kinds is also possible.

Artificial regeneration.

Mulberry is grown in India as either a small bush or a tree; elsewhere it is grown on a variety of systems. Bush mulberry is got by taking cuttings, and putting them in the ground in a bunch of six to eight, each one of the bunch separate but the whole forming a compact bush. Each cutting roots and buds and we get a shrubby growth of shoots about three feet high. These can be plucked, cut down to the ground and a fresh growth of shoots starts. In this way we can get several crops a year. But it requires good soil, good water and good manuring. This is the system of Bengal and Mysore. Shoots are planted as close as eighteen inches apart in the row and the rows two feet apart.

The other existing system is to grow trees: the best are grown from seedlings which are carefully handled from the start and are planted out in permanent positions up to five years old.

The following information bearing on the artificial regeneration of *Morus alba* under Dehra Dun conditions is available from the experiments conducted at the Forest Research Institute.

(1) **Comparison of sowing, stump planting and entire planting.** Planting of stumps and seedlings is generally more advantageous than sowing seed, as the seedlings and stumps survive better and also attain better heights during the first two years.

(2) **Winter stump planting**:—For winter stump planting, it is more advantageous to plant the species under shade as such plants survive better than those planted in the open.

(3) **Date of planting**:—During years with normal distribution of seasonal rainfall, planting at the end of July appears to be most advantageous as regards height growth at the the end of the first growing season; but percentage of survivals remained practically the same for different planting dates between the middle of July and end of August.

(4) **Comparison of nursery and forest stumps**:—Forest stumps are as good as nursery stock and there is no practical difference either in the survivals or heights between the plants raised from both.

In Nilambur, the species was introduced experimentally with teak to serve as a secondary host for teak defoliators. Experiments in Nilambur have shown that both *Morus indica* and *Morus alba* can be grown by planting cuttings and stumps, and that, under local conditions, the former grows faster than the latter. It was also found in Nilambur that *Morus alba* can be established in marshy (but not very marshy) localities and that its increment tends to fall off after 4 years.

Yield Table

Medium

	Main Crop.							Thinnings.			Final Yield.		
Crop age.	Average diameter.	Average height.	Total basal area.	Number of trees.	Timber volume.	Smallwood volume.	Total volume.	Timber volume.	Smallwood volume.	Total volume.	Timber volume.	Smallwood volume.	Total volume.
Yrs.	Ins.	Ft.	C. ft.	No.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C.ft.	C. ft.	C. ft.
6	2.5	13	11	328	—	300	300	—	290	290	—	590	590
10	4.3	30	24	235	10	760	770	—	400	400	10	1,160	1,170
14	5.9	44	38	198	180	990	1,170	—	350	350	180	1,340	1,520
18	7.2	52	51	182	390	1,090	1,480	30	210	240	420	1,300	1,720
22	8.0	57	62	178	530	1,170	1,700	10	120	130	540	1,290	1,830

The following figures of the rate of early growth in Nilambur are available :—

Cuttings planted in 1937

	Morus indica		*Morus alba*	
Year.	Survival %	Mean ht. in ft.	Survival %	Mean ht. in ft.
1940.	100	15.7	100	9.2
1941.	99	20.1	98	10.4
1942.	97	19.3	96	9.6

Morus alba stumps 0.2 to 0.8 in. diam. planted 3×3 ft. espacement.

Year.	Survival %	Av.ht. (ft.)	Increment during the year.	Remarks
1939.	98	1.5	1.5	Swampy locality.
1940.	97	5.0	3.5	
1941.	89	7.6	2.6	
1942.	44.5	8.9	1.3	
1943.	44.5	9.5	0.6	Top shoots drying.

Several varieties of mulberry are grown in Mysore the nomenclature of which is confused. These are mostly varieties of *Morus alba*, including probably *Morusindica*. *Morus alba* var *japoncia* and var. *Philippinensis* have been considered most suitable for silkworms. Two methods of raising mulberry crops are known according as the silkworms or univoltine or multivoltine. For univoltine strains trees are grown. These give one new flush of leaves per annum. They are best grown from nursery seedlings but can also be grown from cuttings. For multivoltine strains, which require up to four new flushes of leaf per annum, bushes are grown from cuttings. Intermediates between trees and bushes are also sometimes grown for obtaining leaves at any specified time.

Mulberry is ordinarily frost hardy. It suffers from the defoliator pest *Margaronia pyloalis*. The fungus *Ganoderma australe* also causes basal rot. There is also considerable browsing damage. Draught takes a heavy toll in irrigated plantations of Punjab when water fails. In the early stages of a plantation weeding is definitely advantageous, if not absolutely essential, for success.

for Mulberry.

Site-Quality.

Accumulated yield of thinnings.			Total yield.			Mean annual increment.		Current annual increment.	
Timber volume.	Smallwood volume.	Total volume.	Timber volume.	Smallwood volume.	Total volume.	Timber volume.	Total volume.	Timber volume.	Total volume.
C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.	C. ft.
—	290	290	—	590	590	—	98		
								3	218
—	690	690	10	1,450	1,460	1	146		
								43	188
—	1,040	1,040	180	2,030	2,210	13	158		
								60	138
30	1,250	1,280	420	2,340	2,760	23	153		
								38	88
40	1,370	1,410	570	2,540	3,110	26	141		

Rate of growth

Sind.

Mulberry is sown in beds under *babul* shade in July 1941, planted out in April-June 1942 and stock left thinned to about 3 ft. × 3 ft. was 6 ft. high in December 1942. After removal of overwood it grew better in the open and attained heights of 0-10 feet in 6 months (M.V. Laurie).

F.R.I., Dehra Dun.

Changa Manga seed, plants 4 months 13 days old while planting on 22-7-1937. Routine weeded.

Results.

Date.	Av. height.
24-11-37	9.7 in.
24-11-38.	18.3 in.
24-11-39.	19.8 in.

4 months 7 days old plant raised in nursery from seed received from Changa Manga, planted in standard pits 12" × 6" on 16-7-37 after plucking off all except the top pair of leaves.

Results.

Date.	Av. height.
22-11-37.	13.9 in.
22-11-38	35.3 in.

Growth of the branch cuttings, F.R.I. New Forest, 12 in. long and 0.3 in. to 0.6 in. thick, planted in July 1936. Routine weedings done.

Results.

Measurement on.	Survivals %	Height (av.)
23-11-36.	74	13.9 in.
16-11-37	46	53.3 in.
1-12-38	48	82.8 in.
17-11.-39	49	119.6 in.

Uttar Pradesh.

Line sowings in 1936 Taungya, 4 seasons growth, measured in January 1940—gave heights of 12 to 15 feet (Champion).

Bombay.

Poona Experimental Garden.—30 plants transplanted in July, reached average height of 4 ft. (some over 6 ft.)

Undivided Punjab.

In Irrigated plantations water plays a very great part and no two trees can be compared unless the quantity of water and the method of irrigation are nearly the same. The following statistics were collected by the Silviculture Branch :—

Age.	Diam.(inches).	Height (feet).
2	-	5
4	0.9	10
6	1.8	20
8	2.8	30
10	3.9	35
12	5.2	40
14	6.3	45
16	7.7	50
18	9.1	55
20	10.6	59
22	12.0	62
24	13.3	65

Conclusion

The very wide distribution of Mulberry, its invasion into the Punjab irrigated plantations and the comparitive ease with which it can be grown in various parts of India by almost any method, notably in Uttar Pradesh by the *Taungya* system and on the Mysore plateau and the Kollegal area of Madras by planting cuttings in cultivation rows, all indicate that it could probably be grown practically all over India. Its excellent coppicing power and rapid growth make it a paying proposition to grow as a fuel crop, and there is no reason why it could not also be grown as timber for sports goods and suitable strains (varieties) which do not branch too much are also found. The admixture of mulberry with other species can also be recommended where trees are being specially grown in grazing areas to provide fodder for lopping. Establishment costs will not be heavy by the *taungya* method where this is feasible.

Mulberry is perhaps one of the very rare tree crops of India which can serve all the important requirements of the Indian villager—fuel, fodder and food,—its edible fruit being palatable and liked by one and all. It has the additional value of contributing an important industrial timber, required in our national economy, and its silviculture deserves therefore to be given closer study and greater importance than what it has received in the past.

NILAMBUR TEAK FORESTS:—THE PHANTOM of my delight.

By D.P. NAGDEV, Assistant Lecturer, M.F.C., Coimbatore.

"What days and what bright years Ah me!
Our life were life indeed with thee."

It was the first time in my life in the year 1934, when in England my professor of forestry spoke to us about Nilambur teak plantations, that I went into raptures over this world-famous teak plantation and its originator, Mr. Conolly, the then Collector of Malabar district. It was in the year 1840 that Conolly brought to the notice of the Government the great difficulty of supplying teak to meet the annual demands of the naval dock yards for ship building purposes, should the indiscriminate fellings in the private forests be allowed to continue without check. He recommended the acquisition by the Government of 260 sq. miles of the forest area to get 12,000 trees planted annually in succession over 60 coupes containing at maturity 2,000 trees yielding 78,000 c.ft. (the average volume of timber per tree being calculated at 39 c.ft.). His object was to have sustained annual yield, It was Mr. Conolly, a Revenue Officer, who was the exponent of the principle of the sustained annual yield. It is on this cardinal principle that all the Government forests of India are being systematically and scientifically managed.

It was since then that I was crazy to see these plantations. After my return from the foreign lands I was employed as Divisional Forest Officer, Kharipur State, Sind, and worked in those thorn forests. Thus the ray of hope of seeing this world famous plantation disappeared. But as Nature would have it, we had to leave our dear home and hearth after the partition of India. Being now an Assistant Lecturer in the Madras Forest College, Coimbatore, I had to take the students for a tour and came down to this phantom of my delight; the Nilambur teak forests.

It was on 17-4-50 that I had the first opportunity of paying my homage to this great man, Mr. Conolly, while visiting the Conolly teak plantations. My thoughts ran back to the past when I was a student and I raised my hat in reverence to my Professor who rightly had said that just as France would not forget Mon: Colbert, India would not forget Messrs. Conolly and Menon.

"Ah then—if mine had been the painter's hand
To express what then I saw".

Those words of my Professor are still ringing in my ears when he said that the success of the germination of the teak seed was due to Mr. Chattu Menon. Were it not for Mr. Menon who was then the Sub. Conservator of Forests and who suggested that the teak seed may be pretreated to accelerate germination, the present Nilambur teak plantation would have been an illusion. This success of teak seed germination led Mr. Conolly to carry out considerable clearings which were planted in 1844 with great success, and this constitutes the origin of the world famous teak plantations of Nilambur.

"Old order changeth yielding place to new". The technique at present of raising plants in the nursery at Nilambur is to sow seed in the nursery beds of 40′ × 4′ × 1′ without any pretreatment, and the transplants which were used in the past have been replaced with the planting of stumps. The seeds are sown in the nursery a year before the work of planting is undertaken.

The area to be planted the next year is clear-felled and the brushwood is burnt and reburnt so that the ash is evenly distributed. Then, after aligning and staking the area at 6′ × 6′, the stumps are planted with the first shower in April. The work of planting is completed by the end of May. The ponamdar puts in the agricultural crop, *viz.*, paddy or *ragi* or a cereal crop. The ponamdar pays about Rs. 50/- per acre per crop as the lease amount. The casualties in the plantation are replaced immediately up to the end of July. The approximate expenditure on raising the teak plantation in Nilambur is Rs. 50/- per acre. Thus the Forest Department not only runs the show economically, *i.e.*, without cost but also helps the Government in the "Grow More Food Campaign". The weeding in this new plantation is also done during the next year. According to the prescription of the working plan 225 acres (75 acres in Plantation Working Circle and 150 acres in Conversion Working Circle) are to be planted with teak in this Division every year.

After the young crop is established uniformly the first mechanical thinning is done in the third year of the crop and the second thinning is done in the sixth year; silvicultural thinnings then follow in the 10th, 18th, 30th and 44th year of the crop. The rotation prescribed is 70 years but for the Conversion working circle it is only 60 years.

"I gazed—and gazed—but little thought
What wealth the show to me had brought".

RECREATIONAL VALUE OF FORESTS

BY MAHENDRA PRAKASH, M.SC., B.SC. (FORESTRY-EDIN), JAIPUR.

"In the wealth of the Woods since the World began
The trees have offered their gifts to man."

—Henry Van Dyke.

Experience from misuse of forests makes man wiser

In the past forests were looked upon merely as Nature's gift to man for the supply of wood. They were cut for cultivation or for the supply of timber or fuelwood ruthlessly. Man from his bitter experience, has now learnt to look upon forests in relation to pleasure, health and beauty. Wanton destruction of forests which led to the dust-bowls, desert conditions and desiccation, loss of fertility of soil, disturbance in rainfall and water-supplies, floods, swamps, and extremes of climate, has now made nations more mindful of their forest wealth. Erosion, which has been termed as "Cancer of the Earth", and has caused the decline and disappearance of civilizations, is the direct result of man's misuse of the earth's "green mantle".

Forest keep climate within bounds

Forests and other vegetation tend to moderate the extremes of seasonal heat and cold, and render climate more equitable. Insolation intensity (Powers of sun rays) in the open is about 12 times greater than in the forests. In summer the mean temperature down to 4 feet in the forest soil is lower than that of the soil in the open, and in winter the foliage of trees (called the canopy) checks radiation from the soil, which is therefore warmer than the scil in the open.

Forest, the Conservator of Water

The decomposing leaves and twigs from the trees along with the interlacing rocts make the forest soil a kind of sponge that absorbs the rain water, which is then made available to springs, wells, tanks and lakes. Forests, therefore equalise the drainage of land. The running water is "made to walk". This is the reason why we must have tree covering on hills and on catchment areas of rivers, to preserve water and to prevent floods. Robert Bridges in his "Nightingale" dexterously points out this scientific fact :—

"Nay barren are those mountains and spent the streams."

"Haunts of nature, Balm to thy sick heart".

Recreation has been defined as comprising of "those outdoor activities of a leisure-time nature which are diversionery in character and afford physical, intellectual and inspirational experiences". There is an inherent desire in man to play and break the monotony of the unvarying round of the routine of daily life. The pleasure of getting away from the drudgery of the daily routine is denied to most of us. Every town must have parks, or wilderness areas near it where its inhabitants can retire into solitude, to cheer or amuse, to refresh after toil and tc get relief and relaxation in weariness, away from the crowd, "the hum, the shock of men, to hear, to see, to feel and to possess and roam along the World's tired denizen". Peace pervades the forest. Tagore talks of the "sacred solitude of the forest."

According to Stevenson, the forests make a claim on our hearts because of "that subtle

something, that quality of the air, that emanation from the old trees, that so wonderfully changes and renews a weary spirit."

Cultural influence of forests

In the forests and woodlands, artists and poets derive food for thought and imagination, thinking men have been influenced in the formation of their Philosophies and the Saints "find the emergence of the spirit through the earthly evil." Almost every one of us belonging to any profession will find something of interest, something of value.

Trees the air-conditioners

Trees purify the air. Their leaves absorb carbon-dioxide gas and in return give out oxygen which is essential for all animals, man included. Forest air contains ozone, and it is free from dust, smoke and the gases that abound in towns. Forests provide protection against cold winds. Such places are thus beneficial to persons suffering from lung diseases. Progressive towns consider their parks and woodland areas as civic assets.

Swamp planting in malaria districts in many of the colonies is well underway. Control of Tse Tse fly in African countries and forestry operations have very close connection.

Forests on the fringe of many of the big towns, besides adding to the beauty of the scene, are the invigorating, recreational places of natural scenery, where the dwellers of big towns could go for a holiday or for a change. Such places have a sedative effect on our mind, distracting our attention from the cares and sufferings of physical existence. In the words of John R. Wise ["New Forest, it's History and Scenery, (1863).]" "Land has higher and nobler offices to perform than to support houses and grow corn, to nourish not so much the body as the mind of man, to gladden the eye with its loveliness, and to brace his soul with that strength which is alone to be gained in the solitude of the moor and the woods."

National Parks and Nature Reserves

Large areas of the forests forming the "pleasuring ground for the benefit and enjoyment of the people" are left aside in many countries where man can see and feel nature in its most undisturbed state. Such amenity areas consist of big and ancient trees, of which there would be no substitude, virgin areas where man's interference has not been allowed to molest the normal progress of nature. These may also contain place of historical or geographical interest or of unique flora. Nature-reserve can form a sanctuary where wild life is also preserved. Such areas make suitable centres for observation of Nature's behaviour when it is allowed to take its own course. Various countries have their own acts and rules with regard to this.

Park enjoyment teaches co-operation and discipline

Park enjoyment is a co-operative activity. Each party or individual thinks of the comforts and convenience of others. Men learn to restrain their actions, they are seen even correcting others. Scouts and Girl-Guides in their camps learn character-building and shouldering responsibility.

THE VANISHING RHINOCEROS AND ASSAM'S WILD LIFE SANCTUARIES.

By P.D. STRACEY, I.F.S., SENIOR CONSERVATOR OF FORESTS, ASSAM.

All three Asiatic Rhinoceroses, the Great One-horned R. unicornis, the lesser one-horned R. sondaicus, and the Two-Horned R. sumatrensis, merit the term " rare ", but the two latter are probably the rarest to-day and the species that are threatened most.

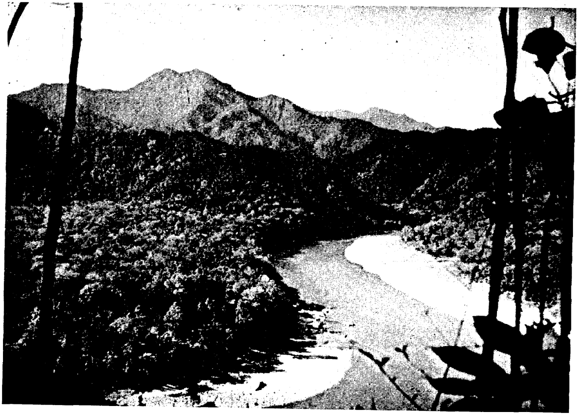
All living rhinoceroses are included in a single family, and though externally similar, differ considerably in their history and anatomy. As a result of extensive migration and adaptation to different climates, terrains, and feeding-grounds the various species became distinct early in their history. Even the two living African representatives (which incidentally are both two-horned, the black or commoner, and the white which is a rarer and larger animal) probably separated and became distinct species as much as a million years ago.

Differences in feeding habits, which in turn develop from originally different environments, has affected the distribution of the various species, the Great One-horned Rhinoceros being mainly confined to the grassy plains of North Eastern India where its specially adapted high-crowned grinding teeth enable it to fulfil it's role as a grazing animal, while the other two species are mainly browsers with short-crowned teeth, and are confined to tree-forest zones. All the species have a three-toed foot, unlike the elephant which has four toes, and all share the habit of wallowing in mud and water. The two-horned Sumatrensis is the smallest of the three, and its skin is smooth and covered with bristles as distinct from its one-horned cousins whose skins are tuberculated, while its ears are fringed with hair. The difference between the Lesser One-horned Sondaicus and the Great One-horned Unicornis is the more pronounced development in the latter of the horn, particularly in the female. In the Unicornis moreover the fold of skin in front of the shoulders is not continued right across the back as is the case in the other two species, while the great armour-like shields of thick skin are very characteristic.

All three Rhinoceroses were once found in Assam, though Lt. Colonel Pollock who was engaged in laying out roads in the Assam Valley and who did a lot of shooting in the country between the years 1860 and 1870, stated that only the two varieties of one-horned Rhinoceroses were found in Assam. A specimen of the two-horned Rhinoceros Sumatrensis, whose range is extensive though everywhere it is rare and extremelly localised, was recorded from the Brahmaputra Valley in 1875. One specimen was killed on a tea-garden in South Sylhet round about 1905 while in the Tanmelong sub-division of Manipur one was killed by some Kukis about 25 years ago in the valley of the Jiri, a tributary of the Burak river. A female Rhinoceros with a calf was seen by a Forest Officer in 1934 near Loharbund, in south Cachar in hilly bamboo jungle and was probably a Sumatrensis. Rhinoceroses are known to exist in the extreme north-eastern corner of Assam in the hilly Frontier National Park of the Manabhum-Daphabum area which lies in the triangle formed by the hills that enclose the end of the Brahmaputra Valley, and it is expected that the species is the Sumatrensis. The Sub-Divisional Officer, Haflong about 15 years ago met a Rheno near Mohur in the North Cachar Hills and took it to be a specimen of the Great One-Horned, but it is more than likely that it was a Sumatrensis, as these animals haunt hill-forests by preference, only wallowing in muddy pools, and the existence of the rear horn is very difficult of detection normally, being quite small. During the Arakan Campaigns of 1943-45, Lt. General Christison took particular care to verify the existence of this species in the Arakan Yomas of Burma, and three specimens were actually seen which he believes were Sumatrensis, though the observers saw only one horn. In Barma to-day it is estimated that there are not more than twenty specimens scattered in various parts of the country, mainly in the Shwe-u-Dauing Sanctuary in Central Burma and in the Arakan Yomas. The species is still found in Malaya, but the disturbed conditions that country is experiencing are not favourable to its survival, though its greater alertness and wariness renders it more fitted to resist persecution than its more helpless cousin, the Sondaicus, which probably survives only in Indonesia to-day.

The Lesser one-horned Sanadaicus was once found along with its larger one-horned cousin in Assam to the South of the Brahmaputra, but to-day this species is probably extinct in Assam as well as in Burma. The last recorded Sandaicus in Assam was from Manipur State in 1874 while one was captured off Chittagong in 1868. In Western Java the species probably numbered around thirty just before World War II and in Sumatra about twenty individuals

Rhinoceros Unicornis
in
Kaziranga Sanctuary.



The Manas Gorge
North Kamrup Sanctuary

were believed to exist round about 1930. But the disturbed conditions in these parts since the end of World War II render the chances of survival of this species even more slender, and in fact it has been listed as requiring immediate preservation by the International Conference on Nature Protection held at Lake Success in 1949.

All the three species of Rhinoceros have suffered persecution at the hands of man throughout the ages as the result of superstitutious beliefs in the magical effects of the horn in rendering poison innocuous, while the Chinese believe that it has a rejuvenating effect, and some Hindus believe that every part of it's body is sacred and valuable. A habit which has probably assisted in their reduction is that of depositing their dung in the same place for some time in what eventually become large heaps as also their habit of wallowing in mud-holes which make it easy for man to lay in wait for them. All the species of Rhinoceroses are reputed to have good hearing and scent, but poor sight, and as a result are inclined to be touchy at times, but they will not attack man unless provoked or suddenly surprised, though like the rogue elephant there is the rogue Rhino! Rhinoceroses held their own fairly well in recent time until advent of the fire-arm, but they have rapidly lost ground since then. In the case of the Sandaicus and Sumatrensis, which mostly inhabit tree-forest, there is less excuse for man to interfere with it, but in the case of the Great One-Horned Rhinoceros, which as I pointed out before, is a grazer and is mainly confined to low-lying grassy areas, there has been a direct clash between its interests and that of man during the past century with the opening up of the grassy plains of North Eastern India for cultivation and grazing.

In Assam this Rhinoceros, which is to-day our sole surviving representative of the race, is found in two distinct types of forests the first type a belt which stretches along the foot-hill of the Himalayas from Nepal through North Bengal as far as the Darrang district of Assam and in which it moves between the grassy swamp of the Terai up through the Bhabar tree forests to the foot-hills, and the second type the grassy areas found near the Brahmaputra river, of which the last surviving remnants to-day are the Kaziranga, Laokhowa and Orange Sanctuaries. Pollok found the animal extremely plentiful eighty years ago in the plains of Goalpara, Kamrup, Nowgong and Darrang in areas where to-day jute and paddy fields stretch in un-broken monotony. He shot 44 in seven years and wounded many more! Those were the days of the smooth-bore gun firing spherical balls and the big-bore black-powder rifle, and quantities of game must have been wounded and lost with such weapons when compared to our modern high velocity rifles, which at any rate have the merit of being clean and merciful killers! He records that the horn of the Rhinoceros was useless as a trophy though prized "by the natives of the country as drinking cups in temples," and that it fetched from 30/- to 45/- rupees a seer (as compared with to-day's price of over 1,000/- rupees per seer!) But while those were the days when the Rhinoceros was allowed to be killed for sport, to-day it is strictly protected and if killed it is by poachers or by excitable people who in some localities, such as the Majuli, apparently cannot resist the temptation to slaughter a Rhinoceros when they see one. In either case in Assam with the great demand among the superstitious for parts of the Rhinoceros, very little remains of the carcases! Recently a male which had wandered across to the Majuli from the Kaziranga Sanctuary was chased and done to death by a crowd of otherwise law-abiding villagers who quickly disposed of every bit of its carcase leaving only the skeleton. Some years ago an almost identical incident took place at Kamalabari-ghat near Jorhat when a Rhino that was swimming across the river was hacked to death in full view of the people at the ghat by men who followed it in boats as it swam. Once a skin which was left to dry under a tree in an Inspection Bungalow had it's feet removed while the Forest Officer slept at night, and this in the heart of a large forest Colony!

Turning to conditions in Assam, to-day, for all practical purposes there is only one Rhinoceros—the Great One-horned Unicornis that holds the stage. This Assam 'Gor' has the distinction of being the largest Rhinoceros in existence to-day, and is the emblem of the State. It was once found in large numbers, and it is said that the ancient Assamese had domesticated it and used it for ploughing. It was also used in battles, if we are to judge from extent illustrations showing a formidable spike mounted on its horn! It was Bengt Berg, the Danish photographer-naturalist, who first drew attention to this animal in 1933 when he photographed them in their natural haunts with the active assistance and encouragement of Shebbeare, who as Conservator in Bengal was then struggling to protect the last surviving Rhinos there, and who hoped to gain in his fight from the publicity which he knew would accrue from Berg's efforts. Berg in his painstaking efforts to get photographs came to the conclusion that

there were not more than 35 to 40 Rhinos left in the whole of Bengal. In Assam at the same time Milroy, who was so akin to Shebbeare in his outlook and methods as a Forest Officer, was struggling with a wave of Rhino-poaching and had to call in the aid of Armed Police. His premature death in 1935 was a great loss to the drive in Assam to put Sanctuaries and Wild Life protection on its feet. But he had laid the foundations and it is on these that all subsequent activities have been based.

There are in Assam to-day three whole-time Sanctuaries, and two Reserves which are treated as such, for the protection mainly of the Rhinoceros, though other rare animals such as Buffaloe, Bison, and Swamp Deer share in the protection which is aimed principally at preserving this vanishing species. Altogether there are some 464 square miles of such Sanctuaries and Reserves, distributed as follows :—

(1). Kaziranga Sanctuary, 166 square miles in extent on the South Bank of Brahmaputra at the foot of the Mikir Hills in Central Assam: a flat low-lying expanse, mainly of reeds and grasses, with streams and open spaces or Bheels where the visitor is quite certain of being able to observe Rhinos, buffaloes, deer, pig etc. at any time. Estimated to contain about 150 head of Rhino, several hundred buffaloes, about 20 elephants and a few swamp deer; this is the "Show-piece" of the Sanctuaries in Assam mainly because of its accessibility.

(2). The Laokhowa Reserve, in Nowgong District 27 square miles in area is similarly situated on the edge of the Brahmaputra and like the Kaziranga Sanctuary consists entirely of flat grassy land; it is estimated to contain about 20-30 head of Rhino and some Buffaloes.

(3). The Orang Reserve, 24 square miles in area in Darrang, is on the north bank of the Brahmaputra and almost opposite the Laokhoa Reserve and similar in type to the two areas mentioned above. Estimated to contain about half a dozen Rhino.

(4). The North Kamrup or Manas Sanctuary is 162 square miles in area, and stretches below the Bhutan hills on the east bank of the Manas river, which debouches from the Himalayas about 100 miles east of Cooch Behar and the border of Bengal. Scenically this is the most attractive Sanctuary in Assam and undoubtedly contains the greatest variety of species, including bison and swamp deer. There are supposed to be more than 100 Rhinos in this Sanctuary, as also up to 200 buffaloes, 100 elephants and 100 bison. Swamp Deer were once to be seen in numbers in this Reserve and in the Kahitama Reserve which extends on the South of this Sanctuary, but are now very scarce.

(5). The Sonai-Rupai Game Sanctuary in Darrang District is 85 square miles in area and like the Manas Sanctuary extends from the Himalayan foot-hills southwards. It is supposed to contain a few Rhino in addition to Bison and a number of elephants This Sanctuary like the Manas, has the advantage of being bordered on the north by the Himalayan foot-hills and is part of a continuous belt of Reserves stretching East and West so that animals are free to move about, but this advantage is nullified by the resultant vulnerability of the area which can effectively be protected only from the south.

The Pabha or Milroy Buffalo Sanctuary, 19 square miles in area is situated in North Lakhimpur and deserves mention in passing, as a Sanctuary created exclusively for the protection of the magnificient species of Assam Wild Buffaloe, of which there are probably some 50-100 animals here. It is possible that this area once had Rhinos and elephants.

These then are the last strongholds of Rhinoceros Unicornis in Assam, and if the small Bengal Sanctuary is included, in the World, for I deliberately exclude the few animals that are to be found in Cooch Behar and Nepal where they are still not protected. What are the prospects of preserving this animal for eternity? Bengt Berg was passimistic and he wrote in his beautifully illustrated book, "On the Trail of the Bhino", that 'in another hundred years the skeletons of this animal will be seen along with similar ones of extinct animals in the Museums of the world and people will stare in wonder.... Zoologists will look with pity and envy on the photos in this book, pity for the poor man who had to put up with such inferior photographic equipment but envy at his luck to have lived before the Rhino became extinct!" Certainly, if we are to judge from the rapid rate of disappearance of this species in the last 100 years, it would appear as if the struggle is hopeless. Yet, it appears as if the Rhino is holding its own in the Kaziranga and North Kamrup (Manas) Sanctuaries at least and if only sufficient assistance can be given to it there is reason to believe that this species can be saved. But will Man in his ruthless search for land and food give the Rhinoceros the peace it requires?

As regards present measures in Assam for increased protection for the Rhino, these are being hampered for want of staff and funds mainly. Two years ago, at the instance of Sir Akbar Hydari, late Governor of Assam, a party of Zoologists from the Bombay Natural History Society visited the Assam Sanctuaries and submitted a comprehensive report and recommendations. Unfortunately very little has been done to implement these recommendations, which are still under the consideration of Government along with detailed schemes submitted by the Forest Department. However, certain measures have been taken in the Kaziranga Sanctuary to increase the Staff and equip them with boats and guns, to increase and improve the accommodation for staff and visitors, and to post more elephants to the Sanctuary, etc. But it is, in the final event, entirely a question of staff and finance and unless the Central Government or some World Body comes forward with money, it is difficult to visualise Assam being able to deal adequately with the problem of preservation of the Great Indian Rhinoceros.

EXTRACTS

BY M.H. QUENOUILLE

(1) Advantages of Planned Experiments*

The main advantage of planned experiments is that valid estimates of treatment effects are obtained the accuracies of which are determined simultaneously. Thus, while in the unplanned, uncontrolled experiment we may possibly be misled concerning the reality of the observed effects, in the planned experiment we are able to specify the odds against an observed effect being due to chance variation. A second point is that the planned experiment will frequently lead to more accurate estimates of treatment effects and consequently to an appreciable saving in labour.

A further advantage in favour of the planned experiment is that the determination of the accuracy of its comparisons frequently allows the experimentation to be extended if necessary. Consequently, the results of any particular investigation can be accurately supplemented by further experimentation. However, in considering the advantages of planned experiments, it should be remembered that these might be nullified if the wrong design is used or if unforeseen difficulties occur. For these reasons, the co-operation and advice of a statistician are to be recommended in the designing of experiments.

(2) Teak in Trinidad

From "Southern Lumberman" for Feb. 1, 1950, page 37.

"Teak grows readily on the island of Trinidad. In recent years substantial quantities of small teak trimmings (the supply of which increases each year) have been used for corduroy roads. In the southern part of the island there is no rock suitable for roadmaking, so that all roads there are of the corduroy type covered with burnt clay. In the main, the woods used for this purpose are those which split readily and for which there is little market as lumber".

(3) Importance of Seed

From "Southern Lumberman", Feb. 1, 1950, page 90.

"**Raleigh, N.C., Jan. 20.**—Speaking before a meeting of the Appalachian Section of the Society of American Foresters in Raleigh, North Carolina, Floyd M. Cossitt, Forester with the U.S. Forest Service, stated to-day that the success of a pine tree plantation may be greatly affected by where the seed came from.

Mr. Cossitt cited results of U.S. Forest Service seed-source studies which are in progress at Bogalusa, Louisiana. The tests show that after 22 years, loblolly pine grown from native Louisiana seed had grown into a timber stand averaging 42 cords of pulpwood per acre. Loblolly pine from seed brought in from Arkansas had grown only one-third the volume of timber produced by the Louisiana seed in 22 years. Likewise Georgia and Texas loblolly seed had produced only about one-half the volume of timber. "This does not mean that trees grown from Louisiana seed are superior to those grown in other states; it merely indicates that native seed grows better 'at home', Cossitt said.

Farmers know what a vast difference select seed makes in the success of their crops. Likewise, studies by the Southern Forest Experiment Station of New Orleans show great differences in tree growth in seed collected at varying distances from the planting site. It is advisable to plant trees grown from seed native to the locality. This will insure the landowner of better tree survival and growth in his forest plantations", Cossitt declared.

(4) You Lose 89 per cent.

From "Southern Lumberman", Feb. 1, 1950, page 62.

Every time salesmen meet some one points out that salesmen trade on time and that to sell more you must spend more time in the presence of your prospects and customers.

Very true, Very true. But did you know that you actually spend just eleven per cent of your time in the presence of those prospects of yours? That you, so far as making direct sales is concerned, throw away—waste, that is, or lose, whichever way you want to describe it—eighty-nine per cent of your life?

(* Extracted from an article entitled "Experimental Design" and published in *Research*, Vol. 3, No. 5, May 1950, pp. 213-217)

Don't get too discouraged about this, because every other salesman, unfortunately, is in the same boat. But may be from reading the figures you can contrive a way to salvage more of yours. And if you do....man, what sales records you'll set for yourself!

Every year contains 8760 hours. The salesman spends 5110 of these in sleep, eating, recreation. Saturdays and Sundays take away 1040 more from his life, and holidays consume another 210 hours. No matter how diligent or conscientious he is, a salesman has idle days—say they cost him 100 hours. He spends 460 hours between calls and waiting for buyers, and wastes 290 hours because he has the idea you can only work six hours a day.

And what's left? Why, there are 290 hours left—eleven per cent of the year's total—for him to spend face to face with prospects, doing his stuff.

If you're smart, you'll see from these figures that you can double your productive time by making one change. You get what it is, don't you? Put in longer days, work longer hours—and become the standout salesman of the year!

(5) Candy Promotes Program

From "Southern Lumberman" Feb. 1, 1950. page 73.

Alexandria, La., Jan. 20.—Fifty thousand sticks of gay peppermint candy, with the message "Keep Louisiana Green—Stop Forest Fires—Grow More Trees" imprinted on their colorful cellophane wrappers, are being distributed to Louisiana children by International Paper Company as part of its continuing forestry educational program.

The idea conceived by Charles W. Robertson, conservation forester, and Miss Edna Potter of the Paper Company's Public relations department, emphasizes to the youngsters, particularly in rural areas, the vital necessity for being cautious with fire in the woods.

The state-wide, cooperative Keep Green program, a plan of public education in forest fire prevention and reforestation, is sponsored by the Louisiana Forestry Association.

TICK REPELLENT

Impregnation of clothing with N-n-butylacetanilide gave consistently good protection against heavy infestations of the lone star tick (*Amblyomma americanum*) in tests made by the U.S. Public Health Service in June 1947 at Camp Bullis, Texas. Measurements ended after the treated garments had been worn 10 days, but the chemical, which was furnished by the Dow Chemical Company of Midland, Michigan, would apparently have been effective for some time longer.

The clothing was worn about 8 hours per day. The repellents under test were evaluated by comparing the numbers of ticks on treated uniforms with those on untreated uniforms. Impregnating a regulation Army fatigue uniform with one ounce of butylacetanilide gave 90% repellency during 10 days of wear, while a 2-ounce impregnation gave 96% repellency. Protection against tick nymphs was greater than against adults—96% and 98% for the two strengths.

Benzyl cyclohexanol ran second in all tests but lost effectiveness after the fifth day. The usefulness of phenyl cyclohexanol was greatly reduced after the third day. Some other chemicals were of some use but performed erratically and gave insufficient protection.

These findings are from an account by James M. Brennan of the U.S. Public Health Service in Public Health Reports for March 12, 1948, Mr. Brennan reports that butylacetanilide does not stain fabrics and has no undesirable odor. No data are available on its toxicity, but related compounds have been pronounced safe from the standpoint of irritation to the skin. No objectionable reaction was found among the 29 persons who wore impregnated clothing. Mr. Brennan suggests that aqueous emulsions —as a 5%emulsion of butylacetanilide in a 2% water solution of laundry soap—would be an effective way of impregnating clothing.

No controlled tests were made on chiggers, but incidental observations suggested that butylacetanilide should afford complete protection from the two common species.
Clement Mesavage.
From:

SOUTHERN FORESTY NOTES

SOUTHERN FOREST EXPERIMENT STATION, NEW ORLEANS, LOUISIANA

Forest Service, U.S. Department of Agriculture

TIMBER WORKERS GET OCCUPATIONAL DISEASE.

Timber research workers in Australia are trying to solve the mystery of skin troubles, such as dermatitis and similar complaints affecting employees handling timber.

Recently a case was reported to the Forest Products Division of the Commonwealth Scientific and Industrial Research Organization in Melbourne where workmen complained of headaches and heaviness in the lungs caused apparently by work on a timber similar to cedar.

Saw-dust prepared for testing was inhaled and caused inflammation of the eyes, irritation of the throat and also nose running.

Irritation extended to the lungs and breathing subsequently became painful and difficult. Chemists in another Division of the organisation carried out preliminary experiments on the saw-dust and have isolated from it a fine white crystaline substance which is now being tested and examined at the physiology department of the University of Melbourne.

Austral News, Vol. 12. *No.* 6., *June,* 1950. *page* 8.

(6) Re-establishment of Greek Woods

By V. DROUVAS

During the difficult periods of her history, Greece has suffered a marked decrease of her wooded areas. This facrt, particularly in some parts of the country, has caused a chronic shortage of the wood products required for the increasing needs of the population. In addition, soil erosion has gone unchecked in the mountainous areas.

Even before the last World War, Greece was poorly supplied with home-grown timber, only about 15 per cent. of the total available area being planted. Unfortunately the toll paid since 1940 has been extremely heavy, not only in human lives, but also in the field of national economy. The war, followed by the hard and ruthless occupation lasting four years, and now the civil war against the Communists assisted from abroad, has resulted in a decrease of some 80 per cent. in the total afforestated areas in Greece. In Attica, woodlands covering 50,000 hectares have been destroyed, while throughout the country some 500,000 hectares have been lost.

The direct and indirect consequences of this loss are most important, particularly if the low national income and the difficulties of reafforestation in a country having poor soil and an extreme climate, are taken into account. Apart from the reduction in the home grown timber supply, agriculture and such public works as irrigation and roads, have been severely affected. The beauty of the Greek landscape beneath its clear blue sky, which was such an attraction to pre-war tourists, has been almost irreparably scarred.

Before their destruction, the Greek woods performed the essential function of tempering the climate. During the heat of the summer, moisture was conserved, while the heavy rain and snow of winter was absorbed and prevented from forming the torrents which now sweep the toil into the sea, carry away roads and bridges, and overwhelm the irrigation systems designed to bring fertility to the farmlands in the valleys.

As soon as it was possible to take stock of the situation of the country as a whole after the occupation, it became apparent that a major reafforestation programme would have to be put into operation at the first opportunity in those areas where regeneration by self seeding was unlikely to take place. It was estimated that some 200,000 hectares, out of the total 500,000 hectares denuded of trees, would require artificial reafforestation.

Despite the continuation of the civil war, a reafforestation drive began last year. This was made possible through American financial aid, and the inspiring impetus given by King Paul, who is President of the National Foundation, an institution which has the rehabilitation of the Greek woodlands as one of its principal aims. With the King's moral support, the assistance of the Government department concerned, and the encouraging number of volunteer workers coming forward, particularly from among the younger generation, it is felt that the cause of reafforestation will soon take the form of a national crusade. This must be achieved since the rehabilitation of the Greek woods is a national necessity.

This work of restoring the woods destroyed must go forward at a vigorous pace. This we underline, since both the climatic and the soil conditions of our country with the variations which they present, do not permit of the work being gradually undertaken over long periods. The uneven nature of the rains, the often violent autumnal rainfall and the prolonged

droughts in certain parts of the country such as Attica and the Eastern Peloponnese are factors which have a most unfavourable effect on the continued productiveness of our soil and therefore on the success of replanting activities. Observations in our country have established that when our woods are destroyed and when the denuded mountain regions are not replanted in time, either by natural seeding or by artificial reafforestation, it nearly always follows that the soil is washed away and finally, with the loss of the humus the limestone rock formations are uncovered.

Consequently, on ground that has thus been eroded, the attempt to reafforest, even if it does not prove to be entirely impossible, must be reckoned as a very difficult and costly effort. For these reasons we consider it imperative that reafforestation works should be put in hand at the earliest opportunity, not only for the easier and more economical replanting of the denuded areas, but also in order that the soil, which is national capital, should not lie fallow. Neither, obviously, is such eroded ground of any use to the stock-breeder.

The question of course arises what sorts of tree should be used in this most important effort. The chief guide in this choice is, irrespective of scientific knowledge and theory, the arboreal vegetation or general plant life already existing in the area to be reafforested.

Even those experts who forget or neglect this sure criterion pay very dearly for underrating or neglecting to observe it. This does not mean that in certain parts, always limited, exceptions do not exist where the change or choice of another type of tree may not result in the success or partial success of this type. In our country with its great differences of arboreal environment, special precaution is needed.

Therefore careful consideration must be paid to the general conditions in each place as well as preference being shown for the indicated tree formation, which in Attica, alas cannot be other than the Aleppo Pine (*Pinus halepensis*), the cypress in the deeper and moister parts, the umbrella pine, though it is slow growing, and among the broad leaved trees, the Acacia (for slope protection) in some places and in moist places the poplar, the Eucalyptus and, we will add, the oak in the cooler and deeper soil to split up the pines and minimize the danger of fires spreading. All these are subjects for the restoration of woodland of an economic or protective nature. If, however, the wood to be restored is of an aesthetic nature, such as a grove, then a departure from this principle may be allowed, provided that the later care and improvement of the wood neutralizes the adverse natural conditions.

And while we are speaking of adverse conditions the question arises as to what is the annual growth in height of the small trees used in afforestation. Certainly this varies according to the soil and climatic conditions in each place, but when the choice of subjects to be planted is indicated, this is always satisfactory.

For example, in the case of the pine, which we regard as the most important type of tree for poor and dry places like Attica, the mean annual growth varies between 15 and 25 cm. Examples occur in not a few cases where the annual growth exceeds half a metre. With us this also occurs in the case of the cypress which even reaches an annual growth of 70 cm.

But this increase in height involves yet another factor, the good use of which depends both on the financial strength and on the experience of the forester. And this factor is the proper organisation of the maintenance and encouragement of growth in the replanting. This stage in man's effort to re-establish the woods is just as important as the first stages of planting, etc. And this is because it is not only a question of attending to the development of the re-established wood, but also of protecting it, in the case of conifers, from certain dangers such as fire, which commonly threaten it with us. It is pure waste of money merely to plant the young trees on ground to be replanted and then leave the rest to Divine Providence. In our country, though it is faced with wide spread devastation, this is realised and it is a case of putting the required organisation into practice in spite of insufficient means. In Greece, unfortunately, there are very few foresters who have organised their planting as fully as His Majesty King Paul and whose results are as manifest as those at the Royal domain of Tatoil,

We must not Forget that when a wood has come to be re-established, it is generally after the destruction of the existing wood, which is both a financial catastrophe for the forester himself and also for the State, especially when its economic position is that of the Greek State, today. How then can we expect a forester to face the expense of this

re-establishment and relative organisation when he has lost practically all his capital and can expect absolutely no State aid, not indeed through any lack of interest or forest consciousness but merely owing to lack of economic means ?

In spite of this the Greek State, through its proper service, under the leadership of the National Institute of King Paul, its districts, communes and private foresters, realising the need of reafforestating barren areas have started during the last two years to work on a programme economically assisted by American Aid, which, if all goes unimpeded, aims at completing the major part of the work in ten years.

Subsequently, when the scheduled works of the current period have been completed, we will give a picture of the reafforestation projects begun since 1948.

NEWSPRINT INDUSTRY:

Prospects of its Establishment in India.

By

CHATTAR SINGH, ASSISTANT PAPER PULP OFFICER, CELLULOSE & PAPER BRANCH,

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The newsprint industry is non-existent in this country at present. India has been wholly dependent on imports from foreign countries for supplies of newsprint. Prior to World War II the total annual import of newsprint averaged over 36,000 tons. This represents a *per capita* consumption of newsprint of less than ¼ lb. for this country; whereas in U.S.A. the corresponding figure is 67 lbs.

CONSUMPTION OF NEWSPRINT.

Of all progressive countries, India has the lowest *per capita* consumption of paper, *viz.*, less than 1½ lbs, of which newsprint accounts for about ¼ lb. This is an extremely low figure for a country of India's vast dimensions and importance. Apart from population growth, the other major factors, which increase the *per capita* consumption of paper, particularly news-

print, are the development of political consciousness among the masses and expansion of education, industries, trade and commerce. After the advent of independence in August 1947, the national Government has been actively engaged in formulating and putting into operation various schemes for the development of industries, commerce, trade and other resources of the country. Among the social and political schemes, the new constitution of the Republic of India has already been framed and put into action, and mass literacy is also receiving due consideration from the Government. The natural result of these economic, social and political developments will be to force up the demand for newsprint to a considerable extent. The import of newsprint has been steadily increasing since the cessation of the last war. In 1948-49 it rose to about 58,000 tons, of the value of Rs. 4,37,87,941. This represents an increase of over 60% over pre-war imports. It would not, therefore, be unreasonable to assume that the annual consumption of newsprint in India would reach the modest figure of 1,00,000 tons in the very near future. The annual consumption of newsprint in U.S.A. in 1949 was 5,529,000 metric tons, equivalent to a *per capita* consumption of 74.1 lb. of newsprint.

Of late the possibility of establishing a newsprint industry in this country has been engaging the attention of the Government and newspaper publishers. Recently considerable publicity has been given to a project for the manufacture of newsprint in this country. Unless the newsprint industry is brought into existence in India, the whole of its future requirement of newsprint, estimated at 1,00,000 tons per annum, will have to be imported from foreign countries belonging to the hard currency block. The value of this quantity of newsprint would be about Rs. 7½ crores at the current price of newsprint. It is high time, therefore, to explore all possible ways and means to push ahead plans for the establishment of the industry in order to stop the great drain on the capital resources of India.

Viewed in the context of social, political and economic development, contemplated at present, the establishment of a newsprint industry in this sub-continent is no doubt a vital national necessity. Shree C.R. Srinivasan, President of the All-India Newspaper Editors' Association, said that need for using steel bullets would not arise if "paper bullets" were used in defence of democracy, for which U.S.A. must give help in allotting more quotas of newsprint to other countries. He further said "if we want to make the world free from communism and safe for democracy, we want more papers to propagate the ideals of democracy and bring about a common outlook for the whole world". In short, the vital roll which newsprint, in the form of newspapers, plays in the economic and political affairs of nations is too well known to need further emphasis.

The Forest Research Institute has been conducting for some time investigations on raw materials suitable for the manufacture of newsprint. These, however, have not yet borne any fruit and the problem of establishment of the industry is far from a satisfactory solution. To achieve satisfactory results it is imperative to make more vigorous and sustained efforts than hitherto to pursue the investigations on more rational and systematic lines.

RAW MATERIAL

As is well known, wood constitutes the most important single raw material in the manufacture of newsprint, the furnish of which consists largely of mechanical pulp. Therefore, the *sine qua non* for the establishment of this industry is the existence of a cheap and plentiful supply of a pulpwood.

CONIFEROUS WOOD

In Europe, America and Canada, which are the largest producers of newsprint in the world, with a total production of about 11 million tons in 1948, newsprint is manufactured mainly from coniferous woods, such as spruce and fir, which have proved to be the most suitable raw material for this purpose. The Indian equivalents of these species, namely, *Picea smithiana* (*Picea morinda*) (spruce) and *Abies pindrow* (fir) (Fig. 1), occur in the hills in the Punjab, Himachal Pradesh, Uttar Pradesh and Kashmir. These species have been found quite suitable for newsprint manufacture. But unfortunately, no detailed field survey of these coniferous forests by experts has yet been undertaken to explore their possibilities for the manufacture of newsprint. Unless this is done, the great potentialities of our coniferous forests for the manufacture of newsprint cannot be assessed with any degree of accuracy. In this connection it is gratifying to note that an initiative in this matter has already been taken by Shree M. D. Chaturvedi, Inspector General of Forests, and Shree C. R. Ranganathan, President, Forest Research Institute & Colleges, who recently visited the coniferous forests of the Punjab. This may serve as a prelude to the starting of a detailed field survey by experts to ascertain the possibilities of utilisation of the resources of the

Fig. 1
Typical View of a fir and spruce forest of the Himalayas

Block No. 1

Photograph showing the finishing off process of the stereotyped plate at the Statesman Press, Delhi.

coniferous forests for the manufacture of newsprint. But existence of pulpwood, even if proved, is not sufficient in itself to ensure its utilization for the production of newsprint. It is the existence of suitable manufacturing facilities, such as availability of cheap power, plentiful supply of clean water, transportation facilities, lime, fuel, cost of primary raw material, proximity to market, etc., occurring associated with pulpwood which will determine the usefulness or otherwise of the pulpwood for the production of newsprint. Before launching a scheme for the establishment of a newsprint industry it is of utmost importance that a careful and expert survey is carried out of all the important factors mentioned above. It is scarcely necessary to over-emphasize this in view of the huge capital investment required to instal a newsprint mill. The smallest economic unit of a newsprint plant will cost about 5 crores to erect.

PRESENT POSITION

The present position, however, resolves into this: that accurate data regarding supplies and costs delivered to a mill site of coniferous pulpwoods and other essential manufacturing facilities, such as water, power, transport, etc., afforded by the coniferous forests, are not available. These data can only be collected by undertaking expert field surveys of the coniferous forests with a view to utilizing their resources for the establishment of a newsprint industry. Such an undertaking would, no doubt, cost about Rs. 4 to 5 lakhs and would probably take about two years to complete, but the Government would be repaid several fold and in addition would derive everlasting benefit if the final result warranted the establishment of an industry of vital national importance, such as the newsprint industry. There is, however, no other half-way house to this and expert surveys will have to be carried out, the sooner the better. This, of course, will need the full co-operation and co-ordinated and sustained effort of a paper technologist, foresters and a logging engineer. The greatest potential value of these field surveys will be, that the possibilities of our coniferous forests for supporting a newsprint industry will be definitely known.

BROAD-LEAVED SPECIES

With vast area of coniferous forests known to be available it is nothing but a counsel of despair to resort to broad-leaved species as a raw-material for newsprint. The broad-leaved trees, the so-called hard-woods, generally have short fibres and consume comparatively more power than conifers to grind them to pulp. Many of the hardwoods produce dark coloured pulps not suitable for newsprint. Nevertheless, in Europe, America and Canada certain broad-leaved species, *e.g.*, poplar and birch, possessing light coloured and soft wood, are utilized for the manufacture of mechanical pulps. But the total tonnage of these hardwoods used for the manufacture of mechanical pulp does not exceed 2% of the total world production of mechanical pulp. The pulp, however, is used mostly for the production of certain varieties of cheap printing papers and finds very limited use in the newsprint industry.

INVESTIGATIONS AT THE FOREST RESEARCH INSTITUTE.

The Forest Research Institute, Dehra Dun, had initiated investigations on the manufacture of newsprint grade mechanical pulp about 12 years ago and tested the following species:

1. *Boswellia serrata* (*salai*).
2. *Lannea grandis* (*Odina wodier*) (*jhingan*).
3. *Garuga pinnata* (*kharpat*).
4. *Eucalyptus globulus* (*blue gum*).
5. *Excaecaria agallocha* (*gengwa*).
6. *Kydia calycina* (*pula*).
7. *Butea frondosa* (*dhak*).

Recently two more species from the Andamans, namely *Sterculia campanulata* (*papita*) and *Sterculia alata* (*letkok*) have also been tested. But none of these has been found suitable for newsprint manufacture for one or more of the following reasons:

1. It is not found occurring compactly in any locality in sufficiently large quantity to warrant its utilization for newsprint manufacture.

2. It yields pulp of dark shade unsuitable for newsprint.

3. It yields pulp possessing extremely low strength values.

QUALITY REQUIREMENT OF NEWSPRINT.

Newsprint possesses certain qualities of colour, finish, opacity, strength, stiffness, fold and ability to take up ink. Newspaper publishers accustomed to a certain standard are likely to demand equal quality in a competitive market. Coni-

ferous woods have been found admirably suited for the production of high quality newsprint. But unfortunately the coniferous forests of India have remained more or less a sealed book as far as their utilization for newsprint is concerned. Unless correct information regarding these resources is ascertained, the prospects to build up a newsprint industry on a permanent basis cannot be predicted with any degree of certainty.

PAPER-MULBERRY.

Recently considerable attention was given to select suitable, fast growing, broad-leaved species, that could be easily grown on large scale in plantations, to fill up the vacuum created by the absence of definite information on the resources of the coniferous forests and the unsuitability of the existing broad-leaved woods for newsprint. Since the original colour of the wood is directly reflected in the mechanical pulp, and in as much as no bleaching agent is customarily used, only light coloured woods can be selected for this purpose. Paper mulberry (*Broussonetia papyrifera*) appeared to fulfil these conditions and is also known to lend itself admirably well to large scale development of plantations. Its sapwood is yellowish white and it grows reasonably fast and thrives in tropical climates. It is reported that it attains the pulpwood size in 9 to 10 years as against 60 to 70 years in the case of spruce and fir, the yield of stem-wood per acre per year, at 10 years rotation for paper mulberry and 80 years rotation for spruce and fir, being about the same in both cases.

INVESTIGATIONS ON PAPER MULBERRY.

Detailed investigations on the Paper mulberry were, therefore, carried out at the Forest Research Institute, to test its suitability for newsprint. Laboratory experiments indicated that the pulp, produced from this wood, possessed satisfactory strength values and other physical characteristics suitable for newsprint production. A *prima facie* case had thus been established to follow up the laboratory investigations by actual large scale commercial tests. For this purpose bulk supplies of mechanical pulp, sufficient for a commercial run of paper, were prepared at the Forest Research Institute and supplied to Shree Gopal Paper Mills together with the requisite quantity of bleached bamboo pulp. Paper, with a furnish of 70% of mechanical pulp and 30 % of bleached bamboo pulp, was run on the paper machine at the Shree Gopal Paper Mills, under the supervision of the writer, without much difficulty. The paper produced was in the form of roll 122″ wide. This roll was subsequently slit and re-wound into reels 35″ wide and 30″ diameter for carrying out commercial printing trials on a high speed rotary press.

PRINTING TRIALS OF EXPERIMENTAL NEWSPRINT.

Two reels of 35″ wide and 30″ diameter of the experimental newsprint were subsequently supplied to " The Statesman " Press, New Delhi, for printing trials on a high speed rotary press. A limited issue of a whole special edition of the "Statesman" bearing the date March 4, 1948, was printed on this paper. A sample of printed sheet is appended at the end. The test is of particular significance as the first of its kind ever attempted in India involving the actual printing of a newspaper on paper made specially for the purpose in an Indian Paper Mill from indigenous raw-materials. The experimental newsprint was found quite satisfactory and compared favourably in strength and other physical characteristics with the Canadian newsprint used for printing " The Statesman ". The results of the investigation have been embodied in the Indian Forest Bulletin, No. 143, " Interim report on the manufacture of newsprint from Paper mulberry (*Broussonetia papyrifera*) ". This publication is available for sale from the Manager, Government Publications, Delhi.

POSSIBILITY OF DEVELOPING PAPER MULBERRY PLANTATIONS.

Although paper mulberry has been found to yield newsprint grade mechanical pulp and is well known for its fast growth, it is not yet known if it would be an economically feasible proposition to raise large scale plantation of this species. As far as is known, in no country in the world has pulp-wood been ever grown like this to feed such an important industry as paper or newsprint. Generally the cost of plantation-grown trees is more than of natural crops.

CONCLUSION.

It is obvious that the great snag in the way of establishing a newsprint industry in India on a permanent basis is, that there is no suitable pulp-wood which is known to be available for immediate exploitation. Pulp-wood species, namely spruce and fir, which have been found suitable for newsprint and

MR. D. P. KHAITAN DEAD

CALCUTTA, Mar 2.—The death occurred here this morning of Mr Debi Prasad Khaitan, a member of the Drafting Committee of the Indian Constituent Assembly, at the age of 60.

The offices of the Indian Chamber of Commerce, of which Mr Khaitan was formerly President and its affiliated bodies, the Bengal Millowners Association and Bengal National Chamber of Commerce, and several business organizations with which he was connected were closed today as a mark of respect.—API

Mr D. P. Khaitan was educated at the Presidency College Calcutta. A well-known figure in Indian business and political circles in Calcutta, he started his career as a solicitor of the Calcutta High Court in 1911. Later, he turned to business and joined Messrs Birla Brothers as a director. He was for a term President of the Federation of Indian Chambers of Commerce, Indian Chamber of Commerce, Calcutta (1928-1930) and Bengal Millowners Association. He was also the promoter and director of several industries and business firms He was a member of the Indian delegation to International Labour Conference, Geneva (1928), Central Banking Commission in India (1929-32), the Indian Jute Inquiry Committee and the Board of Economic Inquiry (1934). He represented Indian industries at the Indo-Japanese Trade Agreement and the Indo-Lancashire Agreement Talks Conference.

Liberal in politics, Mr Khaitan was associated with the late Sir Surendra Nath Banerjea and was a member of the Bengal Legislative Council when the later was a Minister. He was a member of the Bengal Assembly from 194 He served as a Commissioner of Calcutta Corporation from 1921 to 1924 and as a Councillor from 1931 to 1938. He travelled extensively in Europe and America, and was regarded as an authority on economic and financial matters.

Mr Khaitan took a keen interest in sport and was at one time President of the Bengal Flying Club and of the School of Physical Culture.

GANDHI NATIONAL MEMORIAL FUND

COMMITTEE MEETS

The Provincial Committee of the Gandhi National Memorial Fund met at Dr Rajendra Prasad's residence in New Delhi on February 27.

Pandit Nehru Dr Rajendra Prasad, Rajkumari Amrit Kaur, Maulana Abul Kalam Azad, Mr Jagjiwan Ram, Mr Jairamdas Daulatram, Acharya J. B. Kripalani, Mr Devadas Gandhi and Mr J. C. Kumarappa were present.

It was decided to appoint the Punjab National Bank and the Bharat Bank as bankers for the fund in addition to those already announced for the purpose, the Imperial Bank, Central Bank, Bank of India, Hindustan Commercial Bank, United Commercial Bank, Bombay Provincial Co-operative Bank U P Provincial Co-

DEATHS.

D'COSTA—On the 27th February, 1948, at 3-20 p.m., at 5, Hospital Street, Calcutta, Eveline Matilda relict of the late George D'Costa, in her 95th year. Deeply mourned by her children grandchildren, great grandchildren, relatives and friends.

VASUDEVA—On the 29th February, 1948, at Poona, at his nephew's residence, L. Kanshi Ram Vasudeva, of Sargodha, uncle of R. K. Vasudeva, Lt.-Col. A. N. Vasudeva and R. N. Vasudeva. Kirya ceremony in 88, Pataudi House, at 5 p.m., Wednesday 3rd March.

IN MEMORIAM.

[illegible]ERBY—In fond remembrance of our darling mums, Ethel Constance, who departed this life very suddenly on the 25th February, 1947, at Calcutta. To live in the hearts of those we love is not to die. (Inserted by Sheila and Denzil, and family.)

[illegible]STER—In sad and affectionate birthday memory (1st March) of our good and loving mother, and grannie, Olga, Elizabeth, who left us for her Heavenly Home, on the 19th February, 1941. In memory a constant thought, in heart a silent sorrow.

PERSONAL

Written applications are invited for the posts of (a) Principal, and (b) Piano Teacher of Calcutta School of Music. Send details of qualifications, experience, and references to Hony. Secretary, 43, [illegible]ley St., Calcutta.

THE STATESMAN

DELHI, MARCH 4, 1948.

SECULARISM AND RELIGION

WHILE India relies on the secular State to combat Fascism, which here has communal roots, Sir Stafford Cripps advocates "the Christ principle" as "the only conclusive answer to the Fuehrer principle," and contends that democracy without spiritual content is "just another" form of government. This brings to mind that Britain has an Established Church (with which Sir Stafford has close connexions) and therefore, surprising though this may seem, is not strictly describable as a secular State. Though civil disabilities on account of religion do not attach to any class of British subjects, and indeed the Foreign Office is often regarded by the

ment and adaptation are in progress behind the scenes—research on gas turbines is a known instance—they seem unlikely to have advanced to a stage at which grandiose prophecy can be indulged in, or liberties be taken with the fleet as at present equipped. The White Paper says that no new warships will be laid down this year, while the sum allotted for existing construction appears less impressive when it is realized that work on some units has been suspended. The Navy may technically be in a state of transition, but reduction of ships in commission has been carried too far.

The truth seems to be that the British Navy is weak because of three combined factors. A hard-pressed Government has been compelled to economize; there are grave, if possibly temporary, difficulties about man-power; and experts are still groping for a solution of problems posed by amazing sources of energy and "absolute" weapons in general. In a sudden crisis involving another major Power as adversary, Britain and the USA would presumably act together. Unless, however, international discords miraculously abate, Britain cannot long afford the present paring of her Naval strength. Experience between the World Wars grimly indicates the dangers which may be incurred. Financial burdens will be less onerous as—and if—economic recovery progresses, and to the extent that they are shouldered by other nations of the Commonwealth. Should the U.N. as now organized prove incapable of guaranteeing international security, and enormous expenditure on defence be thrust on the democratic nations, these—foreign as well as Commonwealth—may find themselves obliged to pool their resources on a scale greater even than in World War II.

AMIDST the welter of legal phraseology, one remarkable feature of free India's new constitution has perhaps been insufficiently noticed—abolition of untouchability. For over a century Hindu reformers have battled to end this iniquity, which has existed for at least 2,500 years. No doubt Western influence during the last 150 years tended to break down caste barriers, and many caste Hindus, in their fight for fairness and humanity, had to undergo social ostracism. But the greatest blow at the barriers

are known to be available, grow at high elevations in the Himalayas. Their extraction and transport from the forests to the mill site at an economic cost have not yet been satisfactorily solved, and present formidable difficulties. Apart from this, there is no information available regarding the availability of suitable manufacturing facilities afforded by these coniferous forests. The utilisation of conifers is, therefore, out of question for the present because the potentialities of coniferous forests for newsprint have yet to be assessed. Paper mulberry is more or less in the same position. The economics of growing it on a large scale have yet to be proved. In the circumstances the prospects of establishing the newsprint industry on sound and rational lines in the immediate future do not appear to be very bright. The outcome of a detailed expert survey of the coniferous forests could only decide if India would ever be in a position to build up a newsprint industry of its own. The Government should come to the rescue of the industry by helping to resolve the problem by taking early steps to carry out the long overdue, expert field surveys of the Indian coniferous forests. Such surveys can only be undertaken at Government level because the private enterprise has not got either the resources, or the time and patience required for such detailed surveys.

A RATIONAL WAY OF CALCULATING THE GROWING STOCK AND YIELD.

By

R.B. MATHUR, M.Sc.

Student, Indian Forest College, Dehra Dun.

Summary. The growing stock is now calculated taking the periodic current annual increment of the different age classes and its application is indicated for purpose of calculation of Annual Yield.

Introduction.—

1. If there are R acres of forest, (R is also the number of years in the rotation) wherein on each acre a regular crop stands, each crop differing in age from the previous one by one year, we have crops of all ages—1 yr, 2 yr, 3 yr,........R years old,—standing on successive unit areas.

2. The current annual increment (C.A.I.) of a regular crop varies with age; but if we assume that the final mean annual increment (M.A.I.) which is equal to $\frac{\text{Total volume at rotation age}}{\text{rotation age}}$ = i, say, is constant throughout the life of a crop *i.e.*, if M.A.I. = C.A.I. at all ages, then the growing stock can be totalled up as

   i at the end of the 1st year=Volume of 1 yr old crop.

   2i at the end of the 2nd yr=Volume of 2 yr old crop.

   3i at the end of the 3rd yr=Volume of 3 yr old crop.

   Ri at the end of the Rth yr=Volume of R yr old crop; or adding up,

   Total volume at the end of the Growing season $= i+2i+3i+\dots\dots\dots\dots+Ri$
   $= i(1+2+3+\dots\dots\dots\dots+R)$
   $= \frac{i.R(R+1)}{2}$

3. If we start felling one age gradation every year starting from the oldest *i.e.*, removing crop of the oldest age [R years] in the first year, the next older in the second year [also R years then] and so on, during a rotation we would have removed:

   (*a*) the whole of the growing stock and

   (*b*) half the total increment, because in each successive year from the start of the felling the remaining growing stock continued to put on annual increment, *i.e.*

   1 yr old crop becoming 2 yr old,
   2 yr old crop becoming 3 yr old

   (R—1) yr old crop becoming R yr old.

   and also after felling, on areas of each age gradation, started the development of a new crop, the new age gradations getting formed each again differing by one year. And this would become the capital for the next rotation, assuming of course uniform conditions of growth. [Fig. 1]

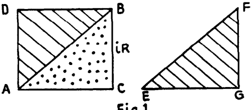

Fig.1

ABC—original growing stock *

ABD—part (half) of increment thereon

EFG—new growing stock formed.

We are thus removing (G.S. + Increment equal to G.S.) in R years. Hence annual yield from the forest taken as a whole,

$= \frac{(G.S.+G.S.)}{R} = \frac{2G.S.}{R}$ (Von Mantel's formula).

4. This method of arriving at the yield involves a big supposition; for, the increment during the life of an evenaged crop is never the same or uniform throughout. The C.A.I. is actually small at the beginning, then

* Growing stock has been abridged to G.S. throughout the article.

increases rapidly during the middle age only to decline after a certain age which corresponds approximately to the age when height growth practically ceases. The volume of an even-aged crop cannot therefore increase by equal amounts in each of the successive years.

The actual volume of the whole crop (consisting of individual crops of all age gradations) is therefore very different from that arrived at by summing up the volumes on final M.A.I. as in para 2, especially for rotations much shorter than the rotation of maximum volume production.

Basing the growing stock or the yield on final m.a.i. can, therefore, only be justified, where c.a.i. cannot be determined.

Calculation of the Growing Stock taking periodic C.A.I.

5. Now suppose, to take a simple case first, we divide the entire growing stock (G.S.) into three parts on age basis as 'Young', 'middleaged' and 'old'. Each age class of the G.S. then occupies R/3 acres with crops of ages as shown below:

G.S :—

1 — R/3	R/3 — 2R/3	2R/3 — R
Young crop	Middleaged	Old
R/3 Acres	R/3 acres	R/3 acres.
Ages 1 to R/3 yrs.	ages R/3 to 2R/3 yrs.	ages 2R/3 to 3R/3—R yrs.

6. Further, assume that
i_1 = mean C.A.I. for all ages in the young crop.
i_2 = -do- -do- middleage crop.
i_3 = -do- -do- old crop.

7. The volume of the part of the G.S. in the 1st group (young) will be equal to the volume of crops of ages 1 to R/3 yrs.

Or $V_1 = i_1 + 2i_1 + 3i_1 + \dots\dots + R/3.i_1$

or putting R/3 = p say.,

$V_1 = i_1\,(1+2+3+\dots\dots+p)$

$= \frac{i_1.p\,(p+1)}{2}$ ....Eqn. (1)

8. (a). At the end of pth year, volume of the crop of age $p = p.i_1$ since so far i_1 was constant as per para 6.

(b). At the end of the (p+1)th year, volume of the same crop or volume of the crop of age (p+1) yrs. $= pi_1+i_2$, ∵ the increment now for the next p yrs is i_2.

Similarly -do- (p+2) yrs. $= pi_1+2i_2$

also -do- (p+3) yrs. $= pi_1+3i_2$

....

....

Vol. of the crop aged (p+p) yrs or 2p yrs. $= pi_1+pi_2$

Adding up, the volume of the part of the G.S. in the entire Middleaged group = Volume of crops of ages (p+1) to 2p yrs.

Or $V_2 = (pi_1+i_2)+(pi_1+2i_2)+(pi_1+3i_2)+\dots\dots+(pi_1+pi_2)$

$= (pi_1+pi_1+pi_1+\dots\dots p \text{ times})+i_2\,(1+2+3+\dots\dots+p)$

$= p.pi_1+i_2\frac{p(p+1)}{2}$

$= p\left\{pi_1+i_2\frac{(p+1)}{2}\right\}$ ....Eqn.(2).

9. At the end of the 2pth year, volume of the crop of age 2p yrs.

$= pi_1+pi_2$
$= p(i_1+i_2)$

∴ Volume of the crop of (2p+1) yrs. old $= p(i_1+i_2)+i_3$

since the increment is assumed to be i_3 for the last p years of the rotation.

Similarly, -do- (2p+2) yrs. old $= p(i_1+i_2)+2i_3$

Also, -do- (2p+3) -do- $= p(i_1+i_2)+3i_3$

....

....

Volume -do- (2p+p) yrs $= 3p = R$ yrs- $= p(i_1+i_2)+pi_3$.

Adding up therefore,
The volume of the part of the G.S. in 'old' group is given by,

$V_3 = p(i_1+i_2)+i_3+p\,(i_1+i_2)+2i_3+\dots\dots\dots+p(i_1+i_2+pi_3$.

$= [p(i_1+i_2)+p(i_1+i_2+\dots\dots\dots p \text{ times.}]+i_3(1+2+3+\dots+p)$.

$= p.\,p(i_1+i_2)+i_3\,\frac{p(p+1)}{2}$ ......Eqn. (3.)

10. Hence the total Growing Stock

$= V_1+V_2+V_3$.

$= \left[i_1\,\frac{p(p+1)}{2}\right]+p\left[pi_1+\frac{(p+1)}{2}i_2\right]$

$+p\left[p(i_1+i_2)+\frac{(p+1)}{2}i_3\right]$

$= p\,\frac{(p+1)}{2}\left[i_1+i_2+i_3\right]+p^2\,(2i_1+i_2)$

$= p.\left[\frac{p+1}{2}\left\{i_1+i_2+i_3\right\}+p(2i_1+i_2)\right]$

........Eqn. (4.)

11. Similarly if we had taken four age classes *i.e.*, if $R/4=p$, the volume of the last age-group $= V_4 = p.\ p(i_1+i_2+i_3) + \frac{p\ (p+1)}{4} i_4$.

$$\therefore\ G.S. = V_1+V_2+V_3+V_4 = \left[\frac{p(p+1)}{2}\left\{i_1+i_2+i_3+i_4\right\} + p^2\ (3i_1+2i_2+i_3)\right]$$

12. Generalising, therefore, if $p = \frac{R}{n}$ *i.e.*, if interval of age classes is reduced and if $i_1, i_2, i_3, i_4, \ldots\ldots\ldots i_n$, are the periodic C.A.I. for the corresponding age classes of interval p, then

$$G.S. = \left[\frac{p(p+1)}{2}\left\{i_1+i_2+i_3+\ldots.+i_n\right\} + p^2\left\{(n-1)\,i_1+(n-2)\ i_2+(n-3)i_3+ \ldots.+i_{n-1}\right\}\right]$$

$$= \frac{p}{2}\left[i_1\left\{p+1+2(n-1)p\right\}+i_2\left\{p+1\ +2\ (n-2)p\right\}+i_3\left\{p+1+2\ (n-3)p\right\}+\ldots.+i_{n-1}\left\{p+1+2(n-\overline{n-1})p\right\}+i_n\left\{p+1+(n-n)p\times 2\right\}\right]$$

$$= \frac{p}{2}\left[i_1\left\{2np+1-p\right\}+i_2\left\{2np+1-3p\right\}+i_3\left\{2np-5p+1\right\}+\ldots+\ldots i_n\left\{2np+1-(2n-1)p\right\}\right]$$

$$= \frac{p}{2}\left[\sum_{t=1}^{n} i_t\left\{2np+1-\overline{2t-1}p\right\}\right]$$

$$= \frac{p}{2}\left[\sum_{t=1}^{n} i_t\left\{2R+1-(2t-1)p\right\}\right],$$

$$\because\ \frac{R}{n} = p$$

or $np=R$

........Equation (5)

The equation in this form is very useful. It has the advantage that with the same age class interval 'p', we can find out the G.S. to any age, a_1, assuming of course that a_1 is also a multiple of 'p' and by substituting a_1 in place of R and putting $n=\frac{R}{p} = \frac{a_1}{p}$, in the above equation (5).

Calculation of this yield.

13. Having known the Growing Stock,

$$\text{Annual Yield} = \frac{2}{R} \times G.S.$$

$$= \frac{2}{np} \times \frac{p}{2}\left[\sum_{t=1}^{n} i_t\ (2R+1-\overline{2t-1}p)\right]$$

$$= \frac{1}{n}\left[\sum_{t=1}^{n} i_t\ (2R+1-\overline{2t-1}\ p)\right] \text{— Equation (6)}$$

14. **Corollary and Check.**

If $i_1=i_2=i_3=i_4=\ldots\ldots=i_n=i=$ Final M.A.I.,

Substituting this in equation (5), we have Annual Yield

$$= \frac{1}{n}\left[\sum_{t=1}^{n} i_t\ (2R+1-\overline{2t-1}p)\right]$$

$$= \frac{1}{n}\Big[\ (2R+1)\ i+(2R+1)i+\ldots..\ n \text{ times}\ ]$$

$$-i\ [\ p+3p+5p+\ldots.+\overline{2n-1}p]\Big]$$

$$= \frac{1}{n}\left[n\times(2R+1)i - i\frac{n}{2}\ [2p+\overline{n-1}\ 2\ p]\right]$$

$$= \frac{n\times i}{n}\left[2R+1-p-np+p\right] = i\left[2R+1-np\right]$$

$$= i\left[R+1\right]\ \because\ np=R$$

Compare G.S. on final M.A.I.

$$= \frac{i\,R\ (R+1)}{2}$$

at the end of the growing season.

$$\therefore\quad \text{Annual Yield} = \frac{2}{R} \times G.S.$$

$$= \frac{i\,R\ (R+1)}{2} \cdot \frac{2}{R}$$

15. Thus value of G.S. based on final M.A.I. is only a special case of the general formula represented by equation (5) and derived as above.

The advantages of calculating yield from equation (6) are:

(a) That it takes into account the actual C.A.I. over the different periods of the life of an evenaged crop; the major defect of assuming final M.A.I. to be the same at all ages is removed.

(b) The formula caters for any degree of accuracy, *i.e.*, on the value of 'p', the interval of age classes depends the accuracy of the calculation of the G.S. These age class groups formed can vary from 3 to $R/p = n$; the lower limit of the value of 'p' is the smallest interval adopted for successive measurements for C.A.I. (This is usually 5 years in practice)

(c) C.A.I./age curve is all that is needed.

Proportion of various age classes in a normal forest

16. If only three age class groups are formed, *viz.*, the young, middleaged and old, then for a normal forest, proportion of volumes of the different groups, young, middle-aged and old should be as:

Eqn.(1) : Eqn.(2) : Eqn.(3).

If there are 'n' age class groups formed, in general, proportion of volumes of the different groups are given similarly by the terms in (1), (2), (3), etc.

17. It should be noted that a ratio given by (7), for the proportion of volumes in the different age classes *alone* governs the normality of a forest. If such a proportion of volumes of the different age class groups as given by (7), is obtained in any other forest over the same R acres—even say in a selection type forest then that forest can be termed a normal forest.

18. **Corollary.**

Again if $i_1=i_2=i_3=i_4 \ldots\ldots = i_n = i$ say. and if $n=3$ the proportion of volumes of young, middleaged and old is given by,—reference equations (1), (2) and (3).

$$\left[\frac{(p+1)}{2}\right] : \left[\frac{(p+1)}{2} + p\right] : \left[2p + \frac{p+1}{2}\right]$$

or as $\frac{R+3}{6} : \frac{R+1}{2} : \frac{5R+3}{6}$ putting $p=R/3$

or as $(R+3) : (3R+3) : (5R+3)$. ——(8).

Example.

If rotation=120 years, and assumed that young ages are from 1 to 40 years.
middle ages are from 41 to 80 years.
old ages are from 81 to 120 years.

Then the vol. of young : vol. of middle-ages : vol of old crop is as $(R+3)$: $(3R+3)$: $(5R+3)$
or as 123 : 363 : 603
or as 1 : 2.95 : 4.9

19. The defect of dividing the growing stock on age basis is that the age below which we call the stock 'young' may not coincide with any recognised diameter class limit; *e.g.*, if we call a crop 'young' below 8·0″ mean d.b.h., then with a rotation of say 120 years and age class interval "p" of 40 years we may not get 8.0″ at exactly 40 years. Instead 8.0 diameter b.h. may be had at 48 years.

This is also true in case of enumerations; if enumerations are done to a lower limit of 8·0″ d.b.h., this may not correspond to an age=one-third the rotation.

So also, the diameter limit after which we call the crop as mature may not necessarily coincide with age=two-third the rotation. [Fig.2].

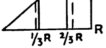

Fig.2.

Dividing the growing stock into recognised diameter classes

20. Let, in general, 'a' be the age which corresponds to the lower limit of the diameter class down to which enumerations have been carried out ; and

'r' be the age which corresponds to the diameter limit above which we term the crop as mature. In general 'a' bears no relation to 'r'. [Fig.3]. R, the rotation age is also assumed to correspond to a certain diameter class limit.

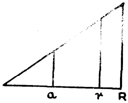

Fig. 3.

21. For the normal forest, Chaturvedi has shown that the proportion of the volumes of the crop below the lower limit of enumeration, (crop below 'a' years) to volume of the middleaged crop ('a' yrs. to 'r' yrs.) and to volume of the old crop ('r' yrs. to R yrs.) should be as

$$a^2 : r^2 - a^2 : R^2 - r^{2*}$$

22. This derivation again involves the assumption that the final M. A. I. age is the same as the M.A.I. at ages 'a' and 'r', an assumption which is hardly ever true.

23. 'a' and 'r' in practice, are generally a multiple of 5 or 10 and so also the age class interval 'p' is 5 or 10. Hence 'a' and 'r' shall be divisible by 'p' generally. (This is only to take a simpler case first. It is not necessary to so assume in a general case which can easily be worked out using equation (5)).

24. The growing stock in a normal forest upto 'a' ages is given by (putting 'a' = R and *a/p=n in Eqn. 5) or*

$$V_1 = \frac{p}{2}\left[\sum_{t=1}^{a/p} i_t\,(2a+1-\overline{2t-1p})\right] \quad \text{Eqn. (9)}$$

The growing stock at 'r' years of age similarly is given by putting r = R and n=R/p =r/p in Eqn.5. or

$$V_r = \frac{p}{2}\left[\sum_{t=1}^{r/p} i_t\,(2r+1-\overline{2t-1\,p})\right] \quad \text{Eqn. (10}$$

assuming of course that the same age class interval 'p' is maintained throughout up to R years of age.

Similarly growing stock in a normal forest of R years is given by Eqn. 5

25. Hence the correct ratio of the G.S. in the different age groups (0 to a), (a to r), (r to R) years, in case of a normal forest should be given by [Fig.4.]

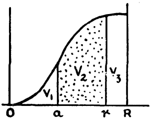

Fig. 4.

$$V_1 : (V_r - V_1) : (V_R - V_r) . =$$
equation (9) : (10) : (5).

26. If the growing stock is calculated in the manner shown above *i.e.*, taking the actual increment at various periods into account, all substitutions for G.S. in numerous formulae for calculation of yield get naturally altered. For example if enumerations are done to half the rotation age, Howard has shown that the

$$\text{Annual Yield} = \frac{V}{3r/8}$$

Where V is the volume measured. If the forest is normal, Annual Yield =2G.S./R on Von

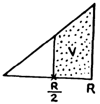

Fig. 5.

**Vide* Indian Forester, Vol LIII, page 22.

Mantel's formula. The volume actually measured, V, and the total G.S. can be related with the help of the eqn. (5)., which is

$$G.S. = \frac{p}{2}\left[\sum_{t=1}^{R/p} i_t\,(1R+1-\overline{2t-1p})\right] \text{Eqn. (5)}$$

And volume of crops of ages upto R/2 yrs. is given by

$$V_{R/2} = \frac{p}{2}\left[\sum_{1}^{R/2p} i_t\left(\frac{2R}{2}+1-\overline{2t-1}\,p\right)\right]$$

Eqn. (11)

$$\therefore \text{ The volume } V = \left[\text{G.S. total} - V_{R/2}\right]$$

$$\text{Hence } \frac{G.S.}{V} = \frac{\frac{p}{2}\left[\sum_{t=1}^{R/p} i_t\,(2R+1-\overline{2t-1}\,p)\right]}{[\text{ Eqn. (5)} - \text{Eqn. (11) }]}$$

=a constant 'c' say. or G.S. = c.v. Then Annual Yield=2cV/R Eqn. (12)

27. This method of finding out the yield (as in para 26) applies to all cases where instead of measuring to half the rotation age, measurements are taken upto any diameter class limit which, let us say, corresponds to any age 'z'.

As in para 26, the G.S. to an age z instead of age R/2 years, is given by equation (5). We have only to substitute 'z' for R and put n=z/p. (Z/p is assumed to be an integer in a simpler case).

Thus the G.S. and that part of it which has been enumerated can be related and value of constant 'c' found out. Yield will be given by the formula (12)——para 26.

A NOTE ON THE MULTIPLE SEEDED RICE OF INDIA

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(Communicated by Dr. K. Kadambi, D.Sc.)

INTRODUCTION

The author collected, in 1933, from the district of Gaya (Bihar) and later from the districts of Ranchi and Singhbhum in Chota Nagpur Hill Tracts, a variety of paddy possessing two or occasionally more grains in one spikelet (Figs. 1, 4, 7). Three successive crops (1933-35) were grown in line cultures and observations made on their vegetative and floral characters. Another sample from Travancore was studied in 1941–42. Such multiple seeded varieties of rice have been recorded by several authors from time to time. A cultivated 'double rice' from Chittagong was named by Prain (1903) as *Oryza sativa* L. var. *plena* Prain, with which nomenclature the polyseeded paddy has since been referred to by Watt (1908) and others. Graham (1913-14), in his classification of the rices of Madhya Pradesh reported a variety from Bilaspur and Narsinghpur having 2 or more grains per spikelet. He regarded this as a definite systematic variety like coloured rices or rices with clustered spikelets. Copeland (1924), Mukerji (1923), Kurup (1936), Bhide (1919), Parthasarathy (1931, 1935), Shen (1933) and Wikramsekhara (1939) have also reported the multiple grained condition to be a regular feature of this paddy. Hedayatullah and Chakravarty (1937) found a double ovaried state as an abnormality in a normal paddy from Sunderban area (Sir Daniel Hamilton's estate, Gosaba).

The present note gives a brief sketch of the agronomical and botanical characters of the type together with some points on its possible systematic (phylogenetic) and economic significance.

DESCRIPTION

The plants are tall, about 115 cm. high, erect (not lodging), and heavily tillering; leaves broad with a light purple margin; sheath axil purple, pulvinus ("junctura" of Hutchinson and Ramiah, 1938) with two light purple marginal rings and numerous light purple dots mainly on the sides between the rings; ligule and auricles prominent and very light purple; stems purple; inflorescence lax and exserted; spikelets 8.1 mm. long and 3.2 mm. broad with two scaly greenish-white outer sterile glumes†; the inner, *i.e.*, 3rd and 4th glumes (lemma and palea, Backer, 1946) broad, green, becoming pale yellow when ripe; apiculus purple, often shortly awned; stamens six; gynaecia usually two, well developed, each with a pair of plumose dark purple stigmas; and grain light red. According to the key characters given by Rhind (1945, p. 40), the specimen may come under *O. sativa* of which numerous varieties are under cultivation. The character of its gynoecium, however, does not conform to that of known species of Oryza.

The number of stigmas per ovary is variable as also is the number of ovaries per flower. Hedayatullah and Chakravarty (1937) recorded trifid stigmas in a double grained variety, Shen (1933) found 3-9 pistils in the Chinese variety and Parthasarthy (1935) observed 2-6-7 ovaries in T. 311. In the present case as many as 4-5 pairs of stigmas were observed in a spikelet (Figs. 5, 6) indicating a multiovaried condition (some of the ovaries had three styles instead of normal two) capable of producing 4-5 grains, though actually not more than three grains ever reached maturity in one spikelet (Fig. 7). Wikramasekhara (1939) also observed 2-3 separate seeds enclosed within the glumes of a single caryopsis and the spikelets contained from 1 to 3 pairs of stigma and a corresponding number of ovaries in T.E.B. I, of Travancore sample. Richharia (1945) states that the presence of 2-5 grains instead of one is due to the fact that every spikelet in the panicle contains 2-5 ovaries. The grain is light red in colour, nonglutinous, slightly curved, narrow, angular and 5 mm. long by 1.7 mm. broad at the widest part (Fig. 2).

Sometimes the grains are unequal as also observed by Shen in the Chinese specimens. In such cases one grain was usually large,

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† Description after Hutchinson and Ramiah (1938) and not in terms of Stapf and Hubbard as discussed by Chatterjee (1947).

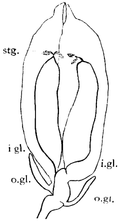

Fig. 1. *O. plena* (Prain) Chowdhury) (Syn. *O. sativa*, L. var. *plena* Prain.) A spikelet containing two ovaries which give rise to two grains on maturity. (*o. gl.*—outer glume ; *i. gl.*—inner glumes (lemma and palea) ; *stg.*—stigmas. (x ca. 6.5).

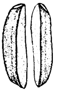

Fig. 2. *O. plena* (Prain) Chowdhury (Syn. *O. sativa* L. var. *plena* Prain.) The twin grains dissected out from the spikelet. Note triangular form of the grains and their flat inner surfaces by which they were appressed to one another in the spikelet. (x ca. 5).

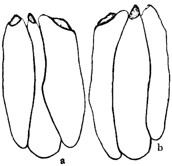

Fig. 3. Triple grains from a spikelet of *O. plena* (Prain) Chowdhury (Syn. *O. sativa*, L. var. *plena* Prain.) The middle grain became pressed to a wedge-like triangular form. a—b, two views. (x ca. 8).

Fig. 4. *O. plena* (Prain) Chowdhury (Syn. *O. sativa* L. var. *plena* Prain). Spikelets cleared in cedar wood oil to show double-ovaried state of flower. Note withering stigmas. (xca. 8.)

Fig. 5. *O. plena* (Prain) Chowdhury (Syn. *O. sativa* L. var. *plena* Prain). Multiple ovaries of a flower. (x ca. 9.)

Fig. 6. Magnified view of the multigynous condition of a flower of *O. plena* (Prain) Chowdhury (Syn. *O. sativa* L. var. *plena* Prain). Note pollen grains sticking to the bushy stigmas. (x ca. 40.)

Fig. 7. A group of 3 grains from a single spikelet (flower). The middle one is pressed to a triangular shape by the side grains. (x ca. 10.)

Fig. 8. *O. plena* (Prain) Chowdhury (Syn. *O. sativa* L. var. *plena* Prain). Single 'ears' of a plant obtained by selection. (x ca. 1/20.)

Photo : CHOWDHURY

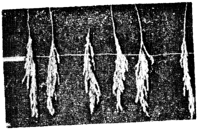

Fig. 8

Fig. 5

Fig. 7

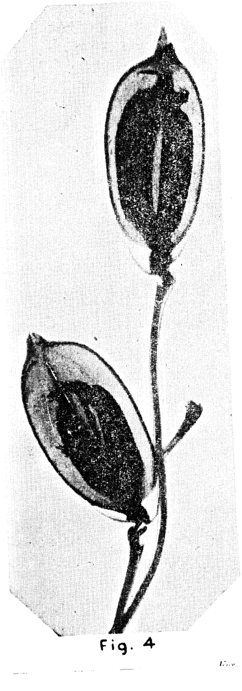

Fig. 4

Fig. 6

For Caption see back page

almost completely filling the entire space while the other was thinner and narrower and pushed against the palea on one side. In other cases the grains had coalesced. Occasional spikelets showed three mature grains (Figs. 3 & 7) of which the middle was flattened between the two lateral crescent-shaped ones. On germination the spikelets usually produced twin seedlings. It is not a case of polyembryony as the two seedlings arise from the two seeds enclosed within the same spikelet and not from one seed (Ramiah, Parathasarthi, Ramanujan, 1935)*.

The spikelets are non-shedding (Fig. 8) and the grain mills satisfactorily. The variety is a late *aman* type and grows well on the same type of soil as the well known Bihar variety "Latisal", which is the standard variety with which it was compared. The yield of this paddy was superior to many others of its class except "Latisal", being about 25-30 mds. (about 2500 lbs.) per acre. The agronomical characters of this paddy are given in Table I and compared with those of "Latisal".

ECONOMIC VALUE

Usually the fine-grained varieties (as seen in Indian Paddy) are low yielders compared to coarse-grained varieties and are therefore not extensively grown, quantity rather than quality being the first consideration with cultivators. The multigynous type here described has a high yield both of grain and straw, second only to that of the best Bihar selections, and therefore combines the characters of good yield and fineness of grain, though the grain is light red in colour. By selection, the author was able to make this variety bear to the extent of nearly 97% of spikelets having two equal sized narrow fine grains, the remaining 3% possessing fused or deformed grains. As Graham remarks, this variety indicates a direction in which "we may look for an increase of the yield combined with the advantage of a fine variety." It also enables considerable seed economy in sowing and transplanting. Kurup (in his letter No. 228/112 dated 1937 addressed to the Director of Agriculture, Travancore)† also expresses the same opinion with regard to selection T.E.B. No. 1 which he finds to be alkali-resistant as well as capable of being grown on normal and acid soils.

Information regarding the occurrence of multigynous paddies in other parts of India is presented in Table II†. There is no record of its occurrence or cultivation in Kashmir Bombay, Orissa, Madras, Mysore, Burma and Ceylon.

DISCUSSION

Sahni (1936, 1938) has described the impressions of paddy husks found on terra cotta remains in the ancient Khokra Kot mounds at Rohtak. These, he says, bear a remarkable likeness to the present double-seeded variety (*O. sativa* var. *plena* Prain) which might possibly have been known and cultivated in the times of the Yaudheyas tribes in the rich province of "Bahudhanake" about 2,000 years ago. Shen (l.c.) records a multigynous form from Szechuan, China, the country of the origion of rice plant (De Candolle, 1904) where paddy has been cultivated for nearly 5,000 years (Bews, 1929). It was observed by Parthasarthy (1935) that when the multiple pistil type was grown out of season *i.e.*, March to July (the normal season is July to December) the anther tips often changed to stigmas and the filaments swelled into ovaries. Many authors including Worsdell (1915) and Chowdhury (1932) have interpreted abnormalities as reversions to a primitive state. Seward (1931) has expressed the view that plants which are confined within limits or have a markedly discontinuous range are old types with a much longer history than others. The multigynous paddy although existing in China and India is not recorded in Burma, a country having long-established communications with China of which it was once a province ; nor is it indigenous to Assam. Its distribution is discontinuous. Worsdell (1916 II, pp. 103, 94) states that "the phenomena of positive dedoublement are in a general way reversional character" and referring to grasses as a whole he observes that "very great reduction in pistil has occurred." Worsdell quotes Celakowsky who regards the two stigmas of the single carpel of grasses as a case of incomplete reduction from two carpels to one. Worsdell also observes "there are, however, several cases in which 3 stigmas make their appearance" indicating "that the immediate ancestors had 3 carpels." In this connection Hedayatullah and Chakravarty's (1937) variety with abnormal spikelets, having one or two ovaries each with 3 stigmas, is interesting, indicating perhaps the possibility of ancestral polycarpellary (polygynous) condition in rice.

* Among other authors who have reported on polyembryony in rice may be named Komura (1922), Rodrigo (1924) and Jones (1928).

† The author is much indebted to the Agricultural Department of the various provinces for supplying the necessary data.

TABLE. I (AGRONOMICAL CHARACTERS.)

Variety and place of collection.	Class.	Time of flowering	Time of harvesting	Year.	Height of of plant in cm.	Number of tillers	Length of panicle in cm.	Length and breadth of spikelet in mm.	Remarks.
I	II	III	IV	V	VI	VII	VIII	IX	X
Double grained variety (Local name : Doo Chaura) collected from Bundu, Ranchi District. Grown at Kanke Farm Ranchi, (Type 4513).	Late *aman*	3rd week of October	2nd week of December	1933	—	18	23.7	7.8/3.2	The figures in columns VI-IX are based on the average of 25-30 readings from 5-6 selected plants.
		,,	,,	1934	114	15	23.0	8.2/3.19	
		,,	,,	1935	97	16	19.0	8.3/3.2	
Double grained variety (Local name : Paatna) collected from Jalghar, Singhbhum District. Grown at Putida farm, Chaibasa.	,,	,,	,,	1935	—	7	20.9	8.1/3.1	The soil of Putida farm is heavy clay, black cotton type; many of the paddies growing well in other places did not do well in this farm.
Latisal. The standard late *aman* paddy of Bihar; collected from Ranchi District and grown at Kanke farm, Ranchi.	,,	,,	,,	1933	—	25	24.0	8.2/2.9	
		,,	,,	1934	92.4	23	23.0	8.5/2.88	
		,,	,,	1935	80.0	20	21.0	8.39/2.81	

TABLE II (DISTRIBUTION).

State.	*Locality of collection.*	*Remarks.*
E. Bengal.	Chittagong ; cultivated at Dacca farm.	Only a curiosity ; poor yielder ; 2-3 grains matured per spikelet.
Assam.	Karimganj farm. Dacca farm variety cultivated.	Late *aman* type ; leaf sheath, axil, leaf margin, pulvinus, ligule, auricles, node and internodes all tinted purple ; stigmas deep purple.
Bihar.	Gaya District ; Ranchi (Bundu) and Singhbhum (Jalghar) districts of Chota Nagpur. Cultivated at the Rice Research farms, Sabour, Kanke (Ranchi) and Putida (Chaibasa).	See text.
Madhya Pradesh.	Bilaspur, Narsinghpur. The variety Ekpandon cultivated at Raipur Rice Research Station.	Medium life-period (ripens about 23rd November). Leaf sheath, axils, ligule, auricles, internodes, apiculus and stigmas all tinted purple. Poor in yield and quality.
Uttar Pradesh.	Nagina Rice Research Station. Travancore variety cultivated. Otherwise not known.	Do Do Examined by the author at Nagina.
E. Punjab.	Khokra Kot, Rohtak. A historic relic.	See text.
South India.	Coimbatore Rice Research Station, (originally obtained from Bengal). Travancore : Selection T.E.B. No. I cultivated at Nanjibad, Vaikom, Shencotta, Trivandrum and Attingal.	Early ; high yielder, non-shedding, alkali resistant. Quality not inferior to local varieties but requires careful milling.
Ceylon.	Peradeniya. Travancore T.E.B. I in pot cultures only.	Refer to Wikramasekhara (1939).

Roy (1951) has recently reported the presence of a third style in rice. It is therefore suggested that the modern monogynous rices may have arisen by reduction from more primitive and antique polygynous forms. The character of the polycarpellary condition in the present type therefore deserves comprehensive study which may perhaps justify its assignment to a specific rank e.g., *O. plena* (Prain) Chowdhury *comb. nov.* (Syn. *O.sativa* L. var. *plena* Prain) of a rather primitive status.

Recently Chandrasekharan, Sunderaraj and Ramanathan (1950) reported in the West African species, *Oryza grandiglumis* Prodoehl., a three styled condition with three vascular strands on the ovary wall in many of its spikelets which were, however, not multiovaried or polyseeded as is the case with the specimen described here. The African as well as our Indian species no doubt support to a great extent the now generally accepted view that the ovary of Gramineae consists of three carpels as against the monocarpellary conception of it held by many (Bews, 1929).

When the manuscript of this paper was ready for the press I came across a contribution by Chatterjee (1948) in which he has also felt the desirability of assigning a specific status to another variety of rice, *viz.*, *O. sativa* L. var. *fatua* Prain (the wild rice of Asia). No doubt there is an urgent need for a proper classification of the varieties or distinct races of O. *sativa*, of which there are as many as fifty or more (Bews, 1929), some of which may deserve species rank.

SUMMARY.

A multiple seeded variety of paddy (*Oryza sativa* L. var. *plena* Prain) is recorded from parts of India, where it is not regarded merely as a curiosity, but is under regular cultivation (Districts of Gaya, Singhbhum, Ranchi). The variety gives a good yield and possesses grains (light red coloured) of a fine type. The suspected occurrence of the prehistoric husk impressions of this type on pottery from the Khokra Kot mounds of Rohtak (Sahni l.c.) its present restricted distribution, its occurrence in China, coupled with the occasional appearance of multiple ovaries in normal paddy (Hedayatullah l.c.) (to be regarded as reversions to the original multipistillate condition) suggest its antiquity and primitive nature and seem to justify its assignment to a separate species. e.g., *O. plena* (Prain) Chowdhury.

I am deeply indebted to Prof. D. Rhind, I.A.S., formerly Professor of Agricultural Botany, Agricultural College, Mandalay (Burma) and Prof. P. Maheshwari, D.Sc., F.N.I., Professor of Botany, Delhi University for kindly going through the manuscript and for the valuable criticisms offered. I am also very thankful to Mr. M.B. Raizada of the Forest Research Institute and College, Dehra Dun and Dr. D. Chatterjee of the Indian Agricultural Research Institute, New Delhi for helpful suggestions and their kind interest in this work.

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PRETREATMENT OF SEEDS WITH COCOANUT WATER TO HASTEN GERMINATION

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The pretreatment of seeds to promote and hasten germination is well known in nursery practice. A common example of the use of chemicals for the purpose is the treatment of the seeds *Acacia arabica* with dilute sulphuric acid. There are also, of course, the traditional indigenous methods, like soaking in a mixture of cowdung and water, which sometimes give good results but whose mechanism of action has not always been explained fully.

Recent developments in the field of Biotics and Antibiotics have focussed attention on the influence of plant of animal products in significantly affecting biochemical processes. A good example is the effect of the sap of *Phytolacca esculanta* as an antibiotic. Biotics and antibiotics are likely to become increasingly important in plant production techniques.

We record here the effect of pretreatment of seeds with cocoanut water on their germination. Cocoanut water is known to be rich in growth promoting factors and had been used as a culture medium. It promises to be of use in forest nursery practice also in aiding germination. The main advantages offered in this application would be that the material needed is handy and there is no necessity of precise dosage and timing of the pretreatment as is needed with, for example, acids. The method would therefore be particularly useful for forest nurseries which have perforce to depend on unskilled labour in out of the way places.

The results of preliminary experiments of a qualitative nature are summarised in this paper. These indicate that soaking of seeds in cocoanut water does induce and hasten germination.

The technique employed was as follows:— Seeds of known origin and date of collection were employed. Six species were selected, the choice being conditioned by the varying degrees of resistance to germination—which experience and preliminary experiments indicated. In each case it was made certain that the seeds were in fact viable by the chemical staining method of the dissected seed, the stain used being triphenyl tetrazolium bromide, ("Grodex", Grand, manufactured by Messrs May and Baker) as the indicator. In each case, 100 per cent viability was established with reference to 25 seeds selected at random from stock. The seeds used were, thus, germinable in each case.

Three sets of 25 seeds each was drawn at random from the stock. One batch (I) was used as control while the other two batches (designated II and III) were experimented upon. Batch I was kept completely immersed in tap water (not distilled water) for exactly the same duration as batches II and III which were kept immersed under cocoanut water. The "cocoanut water" used came from tender green cocoanuts from the same palm grown in Bangalore. After soaking, the seeds were washed in running tap water for about 3 minutes. The daily room temperatures were recorded.

The control and treated seeds were placed in petri dishes (so covered as to permit aeration) on layers of filter paper kept moist throughout the period of observation by addition of drops of distilled water. Germination was deemed to have occurred when the tip of the radicle had elongated beyond the seed coat to show a growing tip.

Table I lists the species used and the date of collection while Table II summarises the results of daily observations.

We were interested in the seeds of *Adenanthera pavonina* in connection with some other work in this Laboratory. It will be noticed that both "treated" and "control" seeds of this species failed to germinate in the above experiments. The following modified technique was employed with this species only :—

100 seeds were soaked for 30 minutes in 50 ml. of 72 per cent sulphuric acid, commercial grade, at room temperature (average 24°C). The acid was decanted away and the treated seeds washed in a stream of tap water for 40 minutes. The seeds had by now developed minute fissures in their coats. The acid used for soaking had taken a red tint.

Fifty of the acid treated seeds were then soaked in cocoanut water while a second lot of acid treated seeds was kept soaked in tap water for exactly the same duration as control —5½ hours. The two batches of seeds were finally washed in running tap water for 10 minutes and then put on moistened filter paper in covered petri dishes for observation.

The results show that in some species like *Ocimum kilimanjaricum* and *Cassia siamea*, the treatment reduces the minimum period of germination and accelerates the rate of germination ; in the cases of *Santalum album* and *Leucaena glauca*, the treatment has apparently no effect ; with Balsa (*Ochroma lagopus*), it promotes germination ; the treatment can also form a valuable auxiliary to other methods of seed treatment as instanced with *Adenanthera pavonina*.

These results warrant the tentative conclusion that soaking of seeds in cocoanut water is a simple and safe technique in the nursery practice with some species.

A TRIP TO BARA BANGHAL IN KANGRA DISTRICT

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Bara Banghal is an outlying pargna of India situated in the inner Himalayas in Palampur Tehsil of the Kangra District. It occupies the head-waters of the River Ravi. The tract in real sense is "Wide" and is off the beaten track, that is away from a sarkari road or even a bridle path. To a traveller such tracts have a peculiar fascination of their own, a shikari will be pleased to find the world famous Brown Bear and the Ibex, and a forester will be greatly benefited if he walks with zealous eyes for forestry.

There are three main ways of getting to Bara Banghal. One from Kulu; one via Chamba territory and one from Baijnath. The way from Kulu is not difficult and is only 4 marches and is across the Kalihani Pass (14,500'). The way from Chamba via Jalsu Pass is 6 marches that is up the Ravi proper; the last two marches are very dangerous, the path goes along precipitous ground, in some places along the face of cliffs with only 6 inches of foot-hold. The 3rd way is from Baijnath and is 4 to 5 marches across the Thomsar Pass (15,500'). I went by the Baijnath way. Before describing the actual trip, however, I would suggest that only a fit person should undertake this trip and a nervous person should not attempt to see the beauty of the track and the valley proper.

Starting from Baijnath the first halt for the night is Bir where there is a beautiful forest rest house. Baijnath (3,500') to Bir (5,000') is 7 miles by the forest bridle-path and the walk is quite pleasant and easy. There are some chil forests on the way. Above the chil there are strips of ban oak (*Quercus incana*) with an admixture of *Rhododendron arboreum*. There is a beautifully regenerated area of chil. The chil regeneration has resulted by simple closure. In open areas, however, the regeneration is completely absent. The undergrowth throughout the track consists of *Berberis*, *Myrsine africana* and *Pyrus pashia*.

Touring from Bir onwards is very difficult and no supplies are available and one has to carry even wheat flour, rice, eggs, etc. There is no dearth of sheep and goats but mutton is a rarity. From Bir we go to Uhl valley the famous catchment area of river Uhl which supplies water to the Mandi Hydro-electric project, and halt for the night at Gundha (8,100'). There is a bridle path from Bir to Gundha which is seldom fit for use even on foot, what to say of going on a pony. Incidentally, there is a short-cut which comes to the rescue of a traveller but is unpleasantly steep and goes up to Slather Pass (9,000'). From Slather Pass to Gundha there is a nice forest inspection path where you can have a decent breath of fresh air after an arduous

climb of some 4,000′ in a distance of just over 3 miles. On the way there are *Quercus incana* forests above which there is a continuous belt of *Quercus semicarpifolia* right up to Gundha. From Slather one can see the beautiful Uhl valley (called Chhota Banghal). River Uhl meanders through the valley and provides excellent trout fishing near about Barot, the headworks station of the Hydro-electric project. There is a comfortable forest hut at Gundha but the forest guard in charge of the hut is seldom at headquarters (usually the forest guards in this area go on *sick-leave* as is warranted by the topographical features of the country) but fortunately the lock usually gives away by a simple blow.

From Gundha onwards there is a good deal of pheasant and black bear shooting. Unfortunately the season was closed for pheasant shooting. On black bear, however, there are no restrictions but I could not stalk even a single animal due to heavy and constant rain and we were forced to halt for the night at Plaschek (7,100′) where there is another forest hut. Next morning it was again raining and the coolies refused to march, but luckily at about 12.00 the sky cleared to some extent and we marched again and had to cross innumerable snow bridges, many of which were on the verge of collapsing due to melting of snow. My party, however, were lucky enough in not meeting with any accident. Up to about 9,500′ there was mainly *Quercus semicarpifolia* forest with a slight admixture of silver fir and spruce, above which there is a small strip of *Betula utilis* and *Rhododendron companulatum* up to 11,000′. From 11,500′ to 13,000′ there is no tree growth but there are straggling bushes of *Juniperus recurva.* For the night we camped at Panihartu (12,000′), a very cold place indeed. The beddings were spread underneath an overhanging rock. Juniper twigs were collected and some sort of tea was prepared to make the ice cold food slightly palatable. After taking our food we got into our beds and were feeling very comfortable but luck did not favour us for long as it began to rain very heavily just after midnight. The so-called beds were all drenched and in an effort to slip away from water, I come into contact with stinging nettle (*Gerardiana heterophylla*) which added insult to the injury. Anyway I was glad that the trip was getting more and more adventurous. The beds had to be vacated rather very early in the morning as the wetness could not be tolerated in that chill. After having a little bite at our three days old food we started on the last march to Bara Banghal village.

From Panihartu onwards the vegetation only consists of alpine pastures, rich in *Mecanopsis*, *Potentilla*, *Caltha*, *Aconite*, *Primula*, *Borage* and *Myosotis*, and above 13,000′ there is practically no vegetation and walking is mostly over snow. The tract from Panihartu to Thamsar Pass (15,500′) is very rugged. Near above 15,000′ one feels the deficiency of oxygen in the air and the breathing gets very rapid and there is a general feeling of giddiness. The use of goggles is very desirable to avoid the ill effect of the reflection of sun rays over the snow. The last 200′ to Thomsar Pass are very tedious on account of sheer rise and the rarified atmosphere. One is, however. amply rewarded on reaching Thomsar. From Thomsar one can see the snow clad peak of Manimahesh if the sky is clear enough; luckily we had the privilege to see the sacred peak. Manimahesh is said to be the residence of *Lord Shiva* and it is a common belief that seeing this peak washes away sins and fulfils one's desires. The trip is so tedious that it is the right place to do away with sins, but the other object regarding the attainment of one's desires, still remains to be verified. The other side of Thomsar pass is very picturesque; beautiful glacier lakes, interesting snow tracks for sliding, lofty mountain ranges covered by perpetual snow, etc. Near about 13,000′ we saw beautiful Himalayan birds (the snow patridges and the snow cocks). *Juniperus recurva* again starts at about 13,000′ and goes down to 11,000′ where it is mixed with *Rhododendron campanulatum.* At 11,000′ we see some silver fir and spruce trees scattered along the precipitous and sheer rocks. From 11,000′ downwards there are mainly silver fir and spruce forests with a slight admixture of kail and a little deodar in lower reaches. We reached the village of Bara Banghal at 4-00 P.M. and were practically exhausted but the forest guard was kind enough to offer us nice hot tea. That night was very comfortable, but for the frequent barks of my little pup; may be under the effect of liquor which was perhaps my servant's courtsey to remove its fatigue.

Bara Banghal is the only village in the valley, consisting of some 200 well built houses on the Kulu pattern, the walls being of loose stone coursed with wooden beams and roofed with shingles (*phattu*) cut from

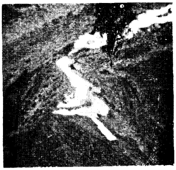

Fig. 1

Uhl River meandering through the valley.
(See the remnants of an old snow bridge)

Fig. 2

Author in a Shephard's hut.

Fig. 3

Bara Banghal Village
(In the fore-ground is River Ravi)

Fig. 4

Spruce, Silver Fir and Kail forests
of the valley.

Fig. 5

Wasteful use of large Fir and Spruce
logs for making shingles.

Fig. 6

A group of local girls.

spruce and silver fir. There are about 500 inhabitants and they possess some 1,500 debilitated cows which have always to be pushed out of one's way. The people, however, are comparatively cleaner than other hill tribes and nobody seems to be poor. The belief in gods is at its extreme and practically every family spends about 200 rupees every year to please his '*devtas*'. *Purdah* is unknown and women folk do the greater part of the work. The people avoid litigation with the result that 95 percent of the disputes are decided by the local *panchayat*. The bulk of the population migrates to Kangra valley during winter as the snow fall is very heavy. The graziers keep busy with their flocks of sheep in this season while others eke out their living by manual labour.

All the forests are undemarcated, protected forests. As already mentioned above the forests are almost entirely composed of kail (*Pinus excelsa*),—silver fir and spruce with very little deodar near about the habitation. There is one peculiarity of the area that oaks are conspicuous by their complete absence, perhaps due to scanty rainfall (25"). The forests are situated generally on the left bank of Ravi River; on the right bank, being the southern aspect, there is, as might be expected, very little forest with the exception of one forest at the mouth of Shah Nala, a tributary of the Ravi. The forests are worked under selection fellings and thinning after an interval of 15 years and this year, I marked some 10,000 trees for felling.

The inhabitants have got the following rights which are exercised in the forests situated near about the villages :—

(i) Timber for building at 2 annas per tree which they use very liberally and waste about 75 per cent of the timber as they take the best '*phattus*' from a tree and leave the rest to rot away in the forest. Deodar is, however, not given except for highway bridges or way side *Dharmsalas*.

(ii) Free grazing for cows.

(iii) Free firewood.

(iv) Free grass cutting.

(v) Free torch wood (*jagnu*).

(vi) Free removal of medicinal plants. (This year *Podophyllum emodi* (*ban kakri*) attracted a good number of traders and some 200 to 300 maunds were exported.)

Besides cattle grazing, there are goats and sheep which come from the plains, many thousands in number, to graze in alpine pastures which provide very nourishing grass during summer and monsoons; but in winter heavy snow falls and the alpine pastures are safe from the intrusion of either man or beast. For this grazing the residents have not got to pay anything but non-residents pay grazing fees (*trini*) to the Government @ $1\frac{1}{2}$ annas per goat and five pice for a sheep.

Now a bit about shikar. The valley is said to be the home of brown bear and ibex and the best season is the month of May when new grass appears in the pastures and one can easily stalk brown bear in the early morning hours or late in the evening. Ibex shooting is, however, very tedious as they live mostly on cliffs which rise sheer for many hundred feet. Unfortunately the writer went to the valley in the last week of July when wild animals are scared away by the graziers to very high altitudes. Anyhow, I could get one brown bear which to my great disappointment was a bald one. The baldness was not a defect with the particular specimen but during rains it sheds its hair to get a very beautiful new coat for the succeeding winter in the month of October. Brown bear feeds mostly on vegetable diet and is harmless but sometimes a stray individual may get into the habit of sheep and goat lifting. In that case it is a great nuisance as it kills a greater number than it actually consumes. One morning a shepherd came to me and told me that a brown bear was causing a good deal of damage to his flock and that its visit is almost regular. I at once got ready with light bedding and rations and reached the spot after about 12 hours continuous walking. It was very cold at the pasture but a light fire was lit and by its side I spread my bedding and was quite comfortable. I instructed them to tie down their dogs so that the beast may come very near the flock without hesitation. At about 10-00 p.m. the dogs began to bark and with the exception of one all got astray as the ropes gave way. The dogs perhaps chased the creature to a distance of some half a mile after which there was lull, the dogs came back and the sheep lifter never turned up that night.

Next morning I went out to see its foot prints as it had rained that night. I soon found the fresh faeces of the bear and then the foot prints and followed them till I found freshly scratched earth and all of a sudden the sheep-boy accompanying me shouted 'sahib bhalu'. The beast heard his voice and took to its heels but after covering a distance of some 10 yards it turned round to have a last look at me; off went an L. G. from my 12 bore, and the creature succumbed instantaneously—it was hit right in the chest. The shepherds were very happy and offered me a goat as '*inam*' which I gladly accepted and gave back to them to have a feast. Thus finished my trip with a kind of chivalry at the end.

It will be interesting to note that on my return journey, the whole distance of 4 marches took me 14 hours and I reached Bir at 9-00 p.m. but was dead tired, none of my coolies or peons could accompany me—they reached 3 days later. Local people say that is a record journey; however, this is my record at any rate.

GAME SANCTUARY IN NORTH KANARA

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General.

"Tigers are getting scarce and are almost extinct in Dandeli" is what formed part of the divisional-administration report of Kanara North division in 1905. It was not until after 35 years that a suggestion was made in the annual administration report of 1940-41 of the same division, that a game sanctuary be formed to protect and preserve the fauna of Kanara because many tigers had since been shot; and apart from tigers cheetal, sambhar and many other animals were rapidly disappearing. The suggestion, having materialized in a proposal, was accepted in September 1941; and necessary steps taken to implement the same by acquiring the *malki* area falling within the proposed game sanctuary and to reserve the Government waste lands under the Indian Forest Act. Before the preliminaries could be completed and game sanctuary brought into being, the matter was dropped under orders from the Government in 1947. It was not until January 1949 that the question of forming a game sanctuary was brought up again at the instance of the Hon'ble Premier (now Chief-Minister) who was anxious to have a National Park in Kanara district for preservation of wild life in order to maintain the balance of nature.

Area and Location.—The Game Sanctuary comprises of the two forest ranges, Virnoli and Kulgi, totalling approximately to an area of 66,462 acres or 104.59 sq. miles lying at the elevation of 470 feet, and includes 23 villages. The area is bounded on the North and the East by Kalinadi river, on the South by Kaneri and Kalinadi-rivers, on the West by the village boundaries of Kumbeli, Talavada, Nagzari, Potoli villages up to Potoli junction and further on by the Dandeli-Potoli road as far as Dandeli. There is very little traffic passing through the sanctuary other than-departmental timber traffic.

Boundaries, North.— The Kalinadi river from Dandeli causeway to the Bomanhalli causeway.

East.—The Kalinadi river from the Bomanhalli causeway to its junction with Tattihalla.

South.—Kalinadi and Kaneri rivers up to the crossing of the Potoli-Gund road.

West.—Village boundaries of Kumbeli, Talawada and Potoli villages.

North-West.—Potoli-Dandeli road up to Dandeli causeway.

Population:—The Game Sanctuary is very sparsely populated. According to the figures obtained from the Revenue Department, there are 536 permanent inhabitants excluding forest subordinates and mazdoors employed on forest works and little less than a square mile (627 acres-11 gunthas) is under cultivation.

The distribution of the population and land is as under:—

Range	Name of village.	Population.	No. of acres under cultivation.	
			Acres.	Gunthas.
Virnoli	Virnoli (including Chavarli)	59	98	7
,,	Phansoli (including Patilwada)	37	38	9
,,	Gavegali (including Bamanya)	153	203	36
,,	Pradhani (including Usheli)	25	44	10
,,	Aurli.	27	31	25
,,	Hudsa	63	66	4
,,	Kalamkhand.	42	4	0
Kulgi.	Kegdal.	76	70	0
,,	Kansirda.	54	71	0
		536	627	11

Note:—For the present the area is restricted to 79.82 sq. miles.

Management.—It is proposed to evacuate the villages within the game sanctuary and settle these villagers near Dandeli to facilitate the development of the sanctuary into a National Park. So far there has been no immediate occasion for appointment of a special game-warden to protect wild life within the sanctuary as it is felt that this protection could satisfactorily be entrusted to the Range Officers of the respective forest ranges at least until such time as the sanctuary is developed as a National Park and any importunate tendency in the meanwhile could be put down by superior forest officers touring in the area.

Control.—Hunting, shooting or capturing of any wild animal or bird or setting up of traps or snares within the sanctuary is prohibited. Provision has been made whereby the Divisional Forest Officer can, with the previous approval of the Conservator of Forests, arrange for the destruction within the Sanctuary of a man-eating tiger or panther, or any other beast dangerous to human life or of elephants and bisons destructive to forest plantations and cultivated crops or of wild dogs and other form of wild life which may become so numerous as to justify destruction. In addition to the gates already existing at the southern end of the causeway on Kalinadi river at Dandeli and on the Bhagwati-Potoli road at Kegdal, it is proposed to put up and maintain gates at the following points :—

(*i*) On Potoli-Joida road near Potoli village.

(*ii*) On Pondakundi-Pondapaval road near Talavada village.

(*iii*) Northern end of the temporary causeway on *Kaneri* river on the Potoli-Gund road.

Besides these, game sanctuary notice boards are proposed to be put up at all gates in addition to those which are already there—with a view to see that the game sanctuary rules are enforced and that there is no poaching or illicit shooting. It is further proposed to have a mobile detection squad.

Except with the permission of the Divisional Forest Officer no one other than a forest officer shall carry any fire arms or explosives into the sanctuary, and the gate duty guards at any barrier on any road leading to, or passing along the boundary of the game sanctuary shall be empowered to stop and search any vehicle. Any forest officer shall also be empowered to stop and search all vehicles within the sanctary.

In addition, no one other than a forest officer shall enter the sanctuary, halt in it, or motor along the roads except under a permit to be obtained from the Divisional Forest officer or any one duly authorised by him in his behalf, in accordance with regulations which may be framed for the purpose.

With regard to forest operations these shall continue within the sanctuary in the usual manner but contractors and their employees shall, during the period they are engaged upon operations, be required to take out free permits for the purpose of entering and halting in the sanctuary.

Flora and Fauna.—There is remarkably a wide range of flora and fauna within the sanctuary and the whole area being very sparsely populated, there is also variety in the wild life.

The Sanctuary contains three distinct types of forest growth. On the West and the South, going deep towards the Nagzari nalla and Kali river, we come across evergreen patches whereas the lower slopes are under the cover of evergreen growth ; towards north-east semi-evergreen forest occurs whereas on eastern side, *deciduous* forest predominates.

As with the *flora* so with the *fauna* we have variations as we go towards the western side. The mouse-deer which can very rarely be seen on the eastern side towards Dandeli is in abundance round about Kaneri river and the semi-evergreen forests of the sanctuary. Elephants which are commonly seen round about Kulgi, Mandurli and Shiroli during monsoons, localise themselves to the lower slopes of the Kali and the Nagzari during the fair season. The pea-fowl which is seen round about Kansirda is noticeably absent as we proceed towards Nagzari valley (For details please see Appendices I, II and III).

Other points of interest.—Apart from the Nagzari valley which presents gorgeous natural scenic beauty within the game sanctuary, the following sites are also of interest.

(*i*) **Nagzari spring**: (Compartment III-I) near the forest rest house Kulgi, is a perennial source of water supply

and a regular watering place for wild life, and thus provides very favourable opportunity for watching, photographing and studying wild life under natural conditions.

(*ii*) **Kalva caves.**—in Kulgi range.

(*iii*) **Shintheri rock.** (Compartment I-23) on the bank of Kaneri river, consists of a single sheet rock ranging up to the height of over 2,000 ft. A number of caves have naturally been formed at the foot of the rock by water action which provide resting place for pigeons.

(*iv*) **Sykes Point.** (XI-A-25) in Kulgi range. It is 1,513 ft. above sea level and commands a view of confluence of Nagzari and Kalinadi rivers at 361 ft. above sea level with Nagzari slopes of both Virnoli and Kulgi ranges in the background. On a clear day the Genesh-Gudi forest rest house of East Kanara division can be seen perched on the hill-top in the distance.

(*v*) **Vincholi rapids** (Kulgi range) are water falls on the Kali river.

Lines of Communication and Rest House. The Sanctuary is easily accessible by rail as well as by road, being 21 miles from Alnavar railway station on the main M.S.M. Rly. There is a net work of forest roads totalling to 89 miles within the game sanctuary, out of which 33 mies 2 furlongs are metalled. The roads are motorable throughout fair weather. Two fully furnished forest rest houses, one at Mandurli (Virnoli Range) and the other at Kulgi, are situated within the sanctuary. Besides these there are two fully furnished rest houses at Dandeli and one at Bhagwati (Sambrani range) within 4 miles of Bomanhalli causeway.

To reach the game sanctuary, one must come to Dandeli which is connected both by road and by train. The Dandeli-Alnavar railway section runs schedule trains twice a week on Monday and Thursday to connect the metre guage M.S.M. railway at Alnavar.

Distances by road.

Dandeli	to	*Mandurli.*	11 Miles.
,,	,,	*Kulgi.*	6 ,,
,,	,,	*Kavla caves.*	12 ,,
,,	,,	*Shintheri rock.*	19 ,,
,,	,,	*Sykes point.*	15 ,,
,,	,,	*Bhagwati.*	15 ,,
,,	,,	*Bomanhalli causeway* (Via Kulgi)	12 ,,
,,	,,	*Bomanhalli causeway* Via Phansoli.	14 ,,
,,	,,	*Alnavar.*	21 ,,
,,	,,	*Belgaum*	63 ,,
,,	,,	*Dharwar.*	35 ,,

APPENDIX I

Animals found in the Game Sanctuary

ANIMALS

	Popular name	*Local name*	*Latin name*
1.	Tiger.	*M. Wagh, K. Huli.*	*Panthera tigris* (Linn)
2.	Leopard or Panther.	*M. Chitta, K. Chirchu.*	,, *pardus* (Linn.)
3.	Stripped Hyena.	*M. Taras*	*Hyaena hyaena Lumacus.*
4.	Wild dog.	*M. Rankutra.* *K. Advi Nai.*	*Cuon alpinus* Pallas.
5.	Elephants.	*M. Hatti.Ane*	*Elephas maximus* Linn.
6.	Gaur or Bison.	*M. Gava, K. Kadkona.*	*Bibos gaurus*, H.Smith.
7.	Sambar.	*M. Sambar.*	*Rusa unicolor* (Kerr.)
8.	Chital or spotted deer.	*M. Narin, Chigari.*	*Axis axis* (Exrl.)
9.	Munt jac or Barking deer.	*M. Bhekar.*	*Muntiacus muntjak* Zimm.
10.	The Indian Chevrotain or mouse deer.	*M. Pasai.*	*Moschiola memina* Hodgson

	Popular name.	Local Name.	Latin Name.
11.	The Indian wild boar.	M.Randukar, K. Kad Handi.	*Sus cristatus* (Wagn).
12.	Langur.	M. *Kale makad* K. *Kare Manga*	*Semnopithecus entellus* (Dufresne).
13.	The Bonnet Macaque.	M. *Lal Makad.* K. *Lal Mangya*	*Macaca radiata* (Geoffroy).
14.	The Leopard cat.	M. *Wagh Manjar.* K. *Huli bekku.*	*Prionailurus bengalensis* Kerr.
15.	The jungle cat.	M. *Ran Manjar.*	*Felis chaus* Guld.
16.	The small Indian Civet.	M. *Mushak,Billi.*	*Viverricula indica* Geoffrey.
17.	The Common palm Civet or Toddy cat.	M. *Jungle Billi.*	*Paradoxurus herma phroditus* Schreeber
18.	The Common Mungoose.	M. *Moongoose.*	*Herpestes edwardsii* Geoffroy.
19.	The wolf.	M. *Landagh.*	*Canis lupus* Linn.
20.	The Jakal.	M. *Kolha.*	*Canis aureus* Linn.
21.	The Indian Fox.	”	*Vulpes bengalensis* Shaw.
22.	The sloth bear.	M. *Aswal.*	*Melursus ursinus* Shaw.
23.	The hardwicks Hedgehog.	M. *Mulhandi*	(*Hemiechinus collaris* Grey).
24.	The small Travancore Flying squirrel.	Har bekku.	*Petinomys fuscocapillus* Jerdon
25.	The Indian Giant. squirrel	M. *Shekra.*	*Ratufa indica* Erxl.
26.	The three-striped palm squirrel	K. *Enachi.*	*Funambulus palmarum* [L.]
27.	The Indian Porcupine	M. *Salendra*	*Hystrix leucura* Gray & Hardwicke.
28.	The hare	M. *Sasa*	*Lepus ruficaudatus* Geoff. ,, *nigricollis* F. Cuv.
29.	The Indian Pangolin or Scaly ant eaters.	Ant eater.	*Manis crassicaudata* Geoffr. St. Hilaire
30.	The jungle fowl.	*Ran Kombadi.*	

Besides this there are a number of bats, rats, beetles, larvae and other mammals like (a) king cobra (b) python etc. of great interest.

(M=maratti—K=Kannam).

APPENDIX II

BIRDS FOUND IN THE GAME SANCTUARY

1. House Crow [*Corvus splendens* (Vicillot)]
2. Jungle crow [*macrorhynchos* (wagler)]
3. The tree pie. [*Dendrocitta vagabunda* (Latham)]
4. The Yellow Cheeked Tit [*Machlolophus xanthogenys* (Vigors)]
5. The chest nut bellied Nut-hatch [*Sitta castane* (Lesson)]
6. The Velvet fronted Nut hatch [*Sitta rontalis* (Swainson)]
7. The Deccan Scimitar Babbler. [*Pomatorhinus horsfieldii* (Sykes)]
8. The Yellow eyed babbler [*Chrysomma sienensis,* (Gmelin)]
9. The Common Iora [*Aegithina tiphia* (Linnaeus)]
10. The green Bul-bul [*Chloropsis aurifrons,* (Temm Laug)]
11. The red vented bulbul. [*Molpastes cafer,* (Linnaeus)]

12. The white cheeked bulbul [*Molpastes leucogenys*, (Gray)]
13. The red whiskered Bulbul [*Otocompsa jocosa* (Linnaeus)]
14. The white browed Bulbul [*Pyononotus luteolus* (Lesson)]
15. The pied bush chat [*Saxicola caprata* (Linnaeus)]
16. The red start [*Phoenicurus ochruros* (S. G. Gmelin)]
17. The Indian robin [*Saxicoloides fulicata* (Linnaeus)]
18. The Magpie robin [*Copsychus saularis* (Linnaeus)]
19. The southern blackbird [*Turdus simillimus* (Jerdon)]
20. The malabar whistling thrush (*Myophoneus horsfieldii*, (Vigors)]
21. The Tickell's blue flycatcher [*Muscicapula tickellioe* (Blyth)]
22. The paradise flycatcher [*Tohitrea paradisi* (Linnaeus)]
23. The wood shrike [*Tephrodornis pondicerianus* (Gmelin)]
24. The scarlet minivet [*Pericrocotus speciosus* (Latham)]
25. The black headed cuckoo shrike [*Lalage sykesii*, (Strickland)]
26. The black drongo or The king crow .[*Dicrurus macrocerus* (Vieillot)]
27. The tailor bird [*Orthotomus sutorius* (Pennant)]
28. The ashy wrenwarbler [*Priniasocialis* (Sykes)]
29. The golden oriole [*Griolus oriolus* (Linnaeus)]
30. The grackle or hill myna [*Gracula religiosa* (Linnaeus)]
31. The grey headed myna [*Sturnia malabarica* (Gmelin)]
32. The brahminy or the black headed myna [*Temenuchus pagodarum* (Gmelin)]
33. The common myna [*Acridotheressristis* (Linnaeus)]
34. The baya or the common weaver bird [*Ploceus philippinus* (Linnaeus)]
35. The yellow throated sparrow [*Gymnorhis xamthocollis* (Burton)]
36. The black headed bunting [*Emberiza melanocephala* (Scopoli)]
37. The Indian wire tailed swallow [*Hirundo smithii* (Leach)]
38. The common swallow [*Hirundo rustica* (Linnaeus)]
39. The large pied wagtail [*Motacilla maderaspatensis* (Gmelin)]
40. The small skylark [*Alauda Gulgula* (Franklin)]
41. The purple sunbird [*Cinnyris asiaticat* (Latham)]
42. The purple rumped sunbird [*Cinnyris zeylonica* (Linnaeus)]
43. Tickells flower pecker [*Dicaeum erythrorhy rchos* (Latham)]
44. The Indian pitta [*Pitta brachyura*(Linnaeus)]
45. The Yellow fronted pied or Mahratta wood pecker [*Dryobates Mahrattensis* (Latham)]
46. The golden backed wood pecker [*Brachypternus benghalensis* (Linnaeus)]
47. The pied crested cuckoo [*Clamator jacobinus* (Boddaert)]
48. The koel [*Eudynamis scolopaceus* (Linnaeus)]
49. The crow pheasant [*Centropus sinensis* (Stephhens)]
50. The Alexandrine or large Indian parakeet [*Psittacula eupatria* (Linnaeus)]
51. The blossom headed parakeet (*Psittacula cyanocephala* [Linnaeus)]
52. The roller or blue jay [*Coracias benghalensis* (Linnaeus)]
53. The common or green bee-eater [*Merops orientalis* (Latham)]
54. The large green bee-eater [*Merops superciliosus* (Linnaeus)]
55. The chest-nut headed bee-eater [*Merops leschenaulti* (Vieillot)]
56. The pied king fisher [*Ceryle rudis* (Linnaeus)]
57. The common king fisher [*Alcedo atthis* (Linnaeus)]
58. The common grey hornbill [*Tockus birostris* (Scopoli)]
59. The hoopoe [*Upupa epops*, (Linnaeus)]
60. The common Indian night jar [*Caprimulgus asiaticus* (Latham)]
61. The barn or screech-owl [*Tyto alba* (Scopoli)]
62. The Indian great horned-owl [*Bubo-bubo* (Linnaeus)]
63. The spotted owlet [*Athene-brama* (Temminck)]
64. The black, pondicherry or king vulture [*Sarcogyps-calvus* (Scopoli)]

65. The white scanvanger [*Neophron, percnopterus* (Linnaeus)]
66. The crested serpent eagle [*Haematornis cheela* (Latham)]
67. The common pariah kite [*Milvus migrans* (Boddaert)]
68. The shikra [*Astur-badius* (Gmelin)]
69. The common green pigeon [*Crocopus phoenicopterus* (Latham)]
70. The blue rock pigeon [(*Columba livia* Gmelin)]
71. The spotted dove [*Streptopelia chinensis* (Scopoli)]
72. The common peafowl [*Pavocristatus*, (Limaeus)]
73. The grey jungle fowl [*Galluss sonneratii*, (Temmink)]
74. The red spur fowl [*Galloperdix spadicea* (Gmelin)]
75. The jungle bush quail [*Perdicula asiatica*, (Latham)]
76. The black partridge [*Francolinus francolinus* (Linnaeus)]
77. The painted partridge [*Francolinus pictus*, (Jardine and Selby)]
78. The grey partridge [*Francolinus pondicerianus* (Gmelin)]
79. The white-breasted water hen [*Amaurornis phoenicurus* (Pennant)]
80. The Indian *moor hen* [*Gallinula chloropus* (Linnaeus)]
81. The coot [*Fulica atra* (Linnaeus)]
82. The painted snipe [*Rostratula benghalensis* (Linnaeus)]
83. The white stork [*Ciconia ciconia* (Linnaeus)]
84. The cattle egret [*Bulbulcus ibis* (Linnaeus)]
85. The cotton teal [*Nettapus coromandelianus* (Gmelin)]
86. The little grebe or dabchick [*Podiceps ruficollis* (Vroeg)]

APPENDIX III

COMMON PLANT SPECIES FOUND IN THE GAME SANCTUARY (NATIONAL PARK) KANARA NORTHERN DIVISION.

	Local Name.	Latin Name.
1.	*Gunja, Gulgunjii.*	*Abrus precatorius.*
2.	*Pisa, Tadgensa*	*Actinodaphne hookeri.*
3.	*Helddi.*	*Adina cordifolia.*
4.	*Alrus.*	*Albizzia lebbek.*
5.	*God hunshi.*	*Albizzia odoratissima.*
6.	*God hunshi.*	*Albizzia procera.*
7.	*Mashe, Fadgus.*	*Alseodaphne semecarpifolia.*
8.	*Satwin Saptaparni.*	*Alstonia scholaris.*
9.	*Bibba.*	*Anacardium occidentale.*
10.	*Rohit.*	*Amoora rohituka.*
11.	*Dindal.*	*Anogeissus latifolia.*
12.	*Ajjanpate, Chandkara.*	*Antiaris toxicaria.*
13.	*Challe.*	*Aporosa lindleyana.*
14.	*Hebbalsu.*	*Artocarpus hirsuta.*
15.	*Fanas, Halsu.*	*Artocarpus integrifolia.*
16.	*Dowga.*	*Bambusa arundinacea.*
17.	*Eppi.*	*Bassia latifolia.*
18.	*Apta.*	*Bauhinia racemosa.*
19.	*Basawanpad* (Climber).	*Bauhinia racemosa.*
20.	*Amli shadloo.*	*Bauhinia malabarica.*
21.	*Basawanpad.*	*Bauhinia lawii.*
22.	*Sawar, semul.*	*Bombax malabaricum.*
23.	*Char Charoli.*	*Buchanania latifolia.*
24.	*Palas Muttal.*	*Butea frondosa.*
25.	*Kaval kumbya.*	*Careya arborea.*
26.	*Bawa kakki.*	*Cassia fistula.*
27.	*Gandhgalgi,* or *Gandhagargi.*	*Cedrela toona.*
28.	*Lal devadar.*	*Chickrassia tabularis.*
29.	*Dalchini.*	*Cinnamomum spp.*
30.	*Bartondi Bhokar.*	*Cordia myxa.*
31.	*Sissum.*	*Dalbergia latifolia.*
32.	*Medar.*	*Dendrocalamus strictus.*
33.	*Karmbel.*	*Dillenia pentagyna.*
34.	*Bile Devadar* white ceder.	*Dysoxylum malabaricum*
35.	*Jambhal, Neral.*	*Eugenia jambolana.*
36.	*Karwat.*	*Ficus asperrima,*
37.	*Karwat.*	Other Ficus spp.
38.	*Kokam.*	*Garcinia indica.*

	Local Name.	Latin Name.		Local Name	Latin Name
39.	*Uppagi.*	*Garcinia cambogia.*	64.	*Honne, Bijasal.*	*Pterocarpus marsupium.*
40.	*Kakad Gojjal.*	*Garuga pinnata.*	65.	*Ghela.*	*Randia dumetorum.*
41.	*Shivan.*	*Gmelina arborea.*	66.	*Womb.*	*Saccopetalum tomentosum.*
42.	*Dhaman.*	*Grewia tiliaefolia.*	67.	*Kusum.*	*Schleichera trijuga.*
43.	*Kalakuda.*	*Holarrhena antidysenterica.*	68.	*Ritha.*	*Sapindus trifoliatus.*
44.	*Holgeri.*	*Holigarna arnottiana.*	69.	*Ashok.*	*Saraca indica.*
45.	*Kasteli, Sarti.*	*Hydnocarpus wightiana.*	70.	*Kadambada.*	*Spondias mangifera.*
46.	*Bhoga.*	*Hymenodictyon excelsum.*	71.	*Kadambada.*	*Spondias acuminata.*
47.	*Lokhandi.*	*Ixora brachiata.*	72.	*Kalam.*	*Stephegyne parvifolia.*
48.	*Ran bhendi.*	*Kydia calycina.*	73.	*Mangyn-tardu.*	*Sterculia guttata.*
49.	*Nandi, Nana.*	*Lagerstroemia lanceolata.*	74.	*Kadukajara.*	*Strychnos nux-vomica.*
50.	*Hole dashal.*	*Lagerstroemia flos-reginae.*	75.	*Hadargitti.*	*Stereospermum chelonoides.*
51.	*Banate.*	*Lophopetalum wightianum.*	76.	*Chincha.*	*Tamarindus indica.*
52.	*Chandota.*	*Macaranga roxburghii.*	77.	*Sagwan, Tegu.*	*Tectona grandis.*
53.	*Gulmav.*	*Machilis macrantha.*	78.	*Arjun.*	*Terminalia arjuna.*
54.	*Kumkum.*	*Mallotus philippinensis.*	79.	*Behada.*	*Terminalia belerica.*
55.	*Amba, Mavu.*	*Mangifera indica.*	80.	*Hiada.*	*Terminalia chebula.*
56.	*Nagar-kada.*	*Morinda tinctoria.*	81.	*Kindal.*	*Terminalia paniculata.*
57.	*Ran Jaiphal.*	*Myristica attenuata.*	82.	*Matti.*	*Terminalia tomentosa.*
58.	*Kan kindal.*	*Nephelium longana.*	83.	*Jarmal.*	*Tetramelcs nudiflora.*
59.	*Modal.*	*Odina wodier.*	84.	*Bondale.*	*Trewia nudiflora.*
60.	*Karimuttal.*	*Ougeinia dalbergioides.*	85.	*Tirfal, Trifal.*	*Xanthoxylum rhetsa.*
61.	*Shib.*	*Oxytenanthera monostigma.*	86.	*Jamba.*	*Xylia xylocarpa.*
62.	*Awala Neral.*	*Phyllanthus emblica.*	87.	*Ghat bor.*	*Zizyphus xylopyrus.*
63.	*Karasinga.*	*Pongamia glabra.*			

ENEMIES OF LAC AND THEIR CONTROL

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The production of lac is virtually a monopoly of India which produces 90% of the world's output.

Lac holds a unique position among natural resins in so far as it is the only one secreted by an insect. Hardly measuring half a millimetre at birth, but swarming in millions, the lac insect produces about 10 to 17 lakhs of maunds of raw lac year after year. The female insect is responsible for producing the total quantity of lac, the male practically taking no part in it. In the original settlement 30% of the lac larvae are males which produce no lac. Out of the 70% female insects about 40% are damaged by the insect enemies of lac and about 20% by natural causes beyond our control. Thus only about 10% of the cells survive to the end of the crop.

Lac is mostly grown by poor cultivators who understand very little about the cause of this loss. Lac, being a chemical compound, does not retain its useful properties if damaged by insect enemies. Therefore damage by insect enemies reduces both the quality and the quantity of lac.

The causes of damage to lac can be divided under four heads:

1. Natural causes.
2. Cultural causes.
3. Enemy insects.
    i. Parasites.
    ii. Predators.
    iii. Other insects.
4. Causes other than insects.

1. NATURAL CAUSES.

Damage by natural causes is unavoidable, as larval settlement is of such a density that if mortality did not occur there would be no room for the development of lac cells.

This is caused by climatic factors such as intense heat, frost and hot dry winds which kill the young lac insects.

2. CULTURAL CAUSES.

The loss due to cultural causes is due to:

(a) Incorrect handling of hosts. It is absolutely necessary to work the host trees as per sylvicultural rules prescribed for each host.

(b) Faulty methods of infection.

Selection of the brood by expert hands before infection is required.

All sticks found with the damage of enemy insects should be rejected.

The brood so infected should be removed from the tree within the prescribed time as keeping such brood on the tree for a longer time will cause the adults of enemy insects to lay eggs on the new crop.

Lac sticks removed from the tree after infection should immediately be taken to the store and scraped, so that the enemy insects may be killed.

(c) Infection with unsuitable strain of brood.

Trees should be infected with a suitable strain of brood *i.e.* Kusum brood should only be used to infect *kusum* trees and not *rangeeni* trees or *vice versa*.

(d) Selection of unsuitable sites.

While selecting an area for lac cultivation care should be taken not to select *kusumi* and *rangeeni* areas side by side, because the enemy insects of one will migrate to the other in the field.

3. ENEMY INSECTS.

(i) **Parasites.** The parasites are all small winged insects; they lay their eggs through a tube or ovipositor which is placed at or near the apex of the abdomen (*i.e.*, on the insect itself). This tube is inserted into the anal cleft opening (through which honey-dew is screted) of the lac cell, and an egg or several eggs are laid on the surface of the lac insect within the lac cell. The adult emerges ready to fly away and repeat the cycle. The damage by a parasite is to a single cell and amounts to 8 to 9%. A list of such parasites is given below :—

1.	*Tetrastichus purpureus.* B. 1.	Chalcididea.
2.	*Eupelmus tachardise.* B. 2.	,,
3.	*Parechthrodryinus claviccrnis.* B. 3.	,,
4.	*Erencyrtus dewitzi.* Y. 1.	,,
5.	*Tachardiaephagus tachaediae.* Y. 2.	,,
6.	*Cocophagus tschirchii.* Y. 3.	,,

Control measure of parasites.

1. Treatment of mature crop on reaping and of all lac that has been used as brood, by the methods suggested under general control.

2. Destruction of the alternative hosts of these enemies.

3. Spraying with lead arsenate. This is not recommended as it causes high mortality of lac insect and lowers the quality of lac.

4. The use of a short inoculation period, not exceeding three weeks.

(ii) **Predators.** Predators are insects which lay their eggs on or near the lac encrustation. The larva hatches from the egg and feeds on lac and the lac insect. It may feed from the surface or it may eat its way into the encrustation, until it comes to lie entirely concealed inside. The attack, however, is from outside and the larva never inhabits one single cell. It pupates inside and the adult emerges to fly and repeat the cycle.

Among the predators, two insects are common and of major importance. They are :—

1. *Eublemma amabilis.* Moor. (Noctiudae)
2. *Holcocers pulverea.* Meyr (Blastobasidae)

(1) *Eublemma amabilis.* Head with short white pinkish hair scales, face deflexed, smooth, thorax silvery white, antannae repose, stretched in front of the head, basal joints enlarged, proboscis more or less flattened, yellowish in colour. The insect has got six generations in 12 months and eight days. The generations are given below.

Generation.	Dates	Duration in days.	Crop effected.
1.	15th July-25th Aug.	42	Katki-Aghani.
2.	25th Aug.-9th Oct.	45	,, ,,
3.	9th Oct.-11th Feb.	125	Baisakhi-Jethwi.
4.	11th Feb.-4th May.	80	,, ,,
5.	4th May-15th June.	44	Katki-Aghani.
6.	15th June-22nd July.	37	,, ,,
		373 days.	

Cold weather generation takes the longest period.

Eublemma laeva destroys about 40-60 cells before it pupates.

(2) *Holcocera pulverea* The newly hatched larva is 1.38 mm. in length. Dorsally it has a shining appearance; the head is chocolate coloured, prothorax light brown, and the rest of the body is pale yellow. The mature larva is dirty brown in colour with fairly long dark setae. The larva gets at the lac insect in the same way as that of *Eublemma amabilis.* The damaged cells contain granular excreta of the larva and snewed lac. It destroys about 45 mature lac cells before it pupates. The predator has five generations in one year and 16 days.

The generations are as below :—

Generation.	Dates.	Duration in days.	Crops effected.
1.	15th July-4th September.	53	Katki-Aghani
2.	5th September 18th Dec.	104	,, ,,
3.	18th Dec.-16th April.	119	Baisakhi-Jethwi.
4.	16th April 12th June.	57	,, ,,
5.	12th June-31st July.	49	Katki-Aghani.
		382	

The third generation being the winter generation takes the longest period to complete the cycle, while the pre-monsoon fifth generation takes the shortest period.

Both the predators *Holcocera* and *Eublemma* are cosmopolitan.

Both do more damage to Katki and Aghani than to Baisakhi and Jethwi crops. If this

damage is estimated even at the rate of rupees ten per maund it will amount to rupees fifty lac every year.

It is therefore absolutely necessary to devise and adopt effective controls to minimise this national loss.

Control measures may be :

1. Cultural measures.
2. Chemical measures.
3. Artificial measures.
4. Biological measures.

1. **Cultural measures.** As explained in the case of *Eublemma amabilis*.

2. **Chemical measures.** The efficacy of having an internal poison as lead arsenate present on the lac at the time when eggs are being laid with various dilutions of sprays. The theory is that the newly hatched larva eating its way into the lac would take poison and die. The spray, however, causes high lac insect mortality and lowers the quality of the lac, and is therefore not recommended.

4. **Artifical measures.** Artificial controls can be applied at the time of crop cutting and on the crop on the tree in the forest, because any treatment applied on the tree will kill the lac insect first. These control measures are:—

a. Water emulsion.

This is a very simple method and needs no extra expense. It is useful for poor people who cannot afford to go in for other elaborate and expensive methods. The best way to carry out this measure is in running water in streams and rivers. It can also be conducted in a village pond the water of which is not used for drinking purposes. The water level of such tanks should be over two feet above the immersed lac sticks. The lac bundles should remain under water for three days. By this time all the lac insects together with the parasites and predators which inhabit the lac are suffocated to death, because they are not water insects and cannot live under water. On the fourth day the lac bundles should be taken out of the water and put on grass to drain off water and dried under shade. In the rainy season lac should be dried in warm rooms. Lac so treated is in no way inferior to that untreated. If sufficient care is not taken the stick lac and shellac prepared out of it may look darker in colour and thereby decrease its value. The advantage of this method is that the treated lac can be scraped easily. The effective results recorded at the Indian Lac Research Institute, Namkum, are given below:

	Weight of scraped. lac	Total number of enemies emerged.
Control.	18 srs- 4 chh.	26,203
Water immersed.	28 srs- 8 chh.	136.

As far as chemical properties are concerned treated lac is as good as untreated lac.

b. Heat treatment.

In this method the lac sticks are heated in a room to different ranges of temperature to kill enemy insects. This method may suit the laboratory but is not practical for the villagers.

4. **BIOLOGICAL CONTROL.** This includes destroying the enemy insects with the help of other insects which feed on them by hyper-parasites. Biological control is very effective but it is not within easy reach of the common cultivator. The following insects have proved to be useful in conrolling the predators :—

(**a**) *Microbracon greeni*. It is an auto-parasite of the *Eublemma larvae*. The female parasite (*M. greeni*) lays her eggs on or near the host larva of *Eublemma*, lying concealed within its galleries in the lac encrustation, paralyses by stinging with her ovipositor and feeds on it.

(**b**) **Apantalis tachardiae.** It is an endo-parasite of *Holcocera*

(**c**) **Pristomerus testaceicolls.** Is also an endo-parasite of *Holcocera*.

The effect of biological control can well be judged from the following figures recorded by the Indian Lac Research Institute, Namkum, from their daily examination of stick lac.

Name of crop.		Host.	Releases of M. greeni.	No. of Eublemma in 100 inches of crop examined. Control.	Experiment
Jethwi.	41.	*Kusum.*	2,124	4.3	2.5
Aghani.	41-42.	,,	10,290	11.1	7.3
Baisakhi.	41-42.	*Palas*	3,440	2.9	2.7
Katki.	43		4,112	10.03	4.5

Other insects and birds.

(**i**) **Beetles.** They appear to feed on the remains of the dead lac insect and other organic rubbish and are not harmful to lac insect.

(**ii**) **Ants.** Trees on which lac is grown are often visited by ants to obtain the honey-dew secreted by the lac insect. In this way they are beneficial as they remove this honey-dew which at times blocks the bracheal pores (breathing holes) thereby causing death of the insect by suffocating. Ants pick up the parasite and predator larvae also. At times certain ants are harmful specially at the time of settlement of lac larvae and male emergence when they kill the lac larvae and male insects. On the whole they are not so harmful. But, if found, a counter attraction of crushed sugarcane or honey comb from which honey has been extracted may be spread on the ground at the foot of the tree. This will form a greater attraction to the ants than the lac insect.

4. ENEMIES OTHER THAN INSECTS.

1. Monkey. Monkeys are seldom serious enemies of the lac insect except that they pull down the brood lac sticks and break the lac twings.

ii. **Squirrels**. Damage by squirrels, where it occurs, is a great nuisance. It can, to some extent, be minimised by putting thorns at the base of the tree.

iii. **Rats**. Damage to lac in the forest by rats is rare. It is only when lac is near the villages that they bite the encrustation. This damage can be controlled by the usual trap methods.

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SAMPLING TECHNIQUES FOR ESTIMATING TREE GROWTH AND VOLUME BY SELECTION OF SAMPLE TREES FOR MEASUREMENT WITHIN INDIVIDUAL SAMPLE PLOTS.

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II

Precision of the Standard Indian Sample Plot Method.

The Standard Indian Sample Plot Method is based on Schwappach's height and form factor curve method with a few modifications. The main departure from Schwappach's method is the arbitrary division of wood into timber and smallwood. Wood above 8" diameter over bark is considered timber and below 8" down to 2" diameter over bark smallwood.

In an article in the *Indian Forester* of October 1934, H. G. Champion and later in January 1937, M. A. Kakazai dealt with the value and purpose of sample plots. Both the authors made a test of the precision of the Standard Indian Sample Plot Method by comparing the figures derived with the help of a set of sample trees selected in the usual way, with the actual figures obtained after clear felling. They ascribed the presence of big differences between the estimated and the actual crop figures, in some of the clear felled sample plots, to the selection of inadequate and insufficiently representative sample trees. In part I*, we have also seen that the figures calculated statistically and obtained from the set of sample trees selected by sample plot parties, are in most cases not only higher than the actual figures but also higher than those derived from other sampling schemes. Hence it could be asserted that the present method of selecting sample trees is decidedly biased and faulty. Efforts should, therefore, be made to improve and introduce such sampling techniques as may enhance precision.

For this purpose, if the method of selecting sample trees by stratified random sampling scheme is strictly followed and sample size too is slightly increased from about 6 to 10, the precision is bound to be enhanced. In part I, this technique has been thoroughly discussed, and

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Table (16): Comparison of crop figures obtained by (i) direct measurements, (ii) statistical method and (iii) Schwappach's height and form factor curve method.

Species	S.P. No.	Division	Method of selecting sample trees	Method of calculation	Sample size	Mean height (ft.)	Total wood volume (c.ft.)	Percentage difference	
								Mean height	Total wood volume
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dalbergia sissoo	5	Montgomery	Clear felling	Direct method	Whole crop	45	657	..	..
			Sample of choice	Schwappach's method	8	46	673	+2.2	+2.4
			Stratified random sampling	do	10	45	643	0	—2.1
			do	do	15	45	650	0	—1.1
			do	do	20	46	656	+2.2	—0.2
			do	Statistical method	10	43	676	—4.4	+2.9
			do	do	15	43	621	—4.4	—5.5
			do	do	20	44	662	—2.2	+0.8
Dalbergia sissoo	8	Montgomery	Clear felling	Direct method	Whole crop	47	1287	..	..
			Sample of choice	Schwappach's method	12	50	1342	+6.4	+4.8
			Stratified random sampling	do	10	46	1279	—2.1	—0.6
			do	do	15	46	1256	—2.1	—2.4
			do	do	20	46	1234	—2.1	—4.1
			do	Statistical method	10	43	1173	—8.5	—8.9
			do	do	15	44	1242	—6.4	—3.5
			do	do	20	44	1265	—6.4	—1.7

Table (16): Comparison of crop figures obtained by (i) direct measurements, (ii) statistical method and (iii) Schwappach's height and form factor curve method.—(*Contd.*)

Species	S.P. No.	Division	Method of selecting sample trees	Method of calculation	Sample size	Mean height (ft.)	Total wood volume (c.ft.)	Percentage difference	
								Mean height	Total wood volume
(1)	(2)	(3)	(4)	(5)	(6)	7	(8)	(9)	(10)
Morus albc ..	27	Lahore	Clear felling	Direct method	Whole crop	52	739	..	..
			Sample of choice	Schwappach's method	6	53	785	+1.9	+6.2
			Stratified random sampling	do	10	55	776	+5.8	+5.0
			do	do	15	51	715	−1.9	−3.2
			do	do	20	52	740	0	+0.1
			do	Statistical method	10	52	713	0	−3.5
			do	do	15	48	686	−7.7	−7.2
			do	do	20	49	704	−5.8	−4.7
Shorea robusta ..	36	Ramnagar	Clear felling	Direct method	Whole crop	106	4220	..	..
			Sample of choice	Schwappach's method	7	106	4151	0	−1.6
			Stratified random sampling	do	10	107	4233	+0.9	+0.3
			do	do	15	103	4229	−2.8	+0.2
			do	do	20	107	4236	+0.9	+0.4
			do	Statistical method	10	106	4182	0	−0.9
			do	do	15	103	4269	−2.8	+1.2
			do	do	20	106	4234	0	+0.3

Table (16): Comparison of crop figures obtained by (i) direct measurements, (ii) statistical method and (iii) Schwappach's height and form factor curve method.—(*Contd.*)

Species	S.P. No.	Division	Method of selecting sample trees	Method of calculation	Sample size	Mean height (ft.)	Total wood volume (c.ft.)	Percentage difference	
								Mean height	Total wood volume
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Shorea robusta ..	1	Buxa	Clear felling	Direct method	Whole crop	80	1147	..	..
			Sample of choice	Schwappach's method	6	81	1134	+1.3	−1.1
			Stratified random sampling	do	10	80	1168	0	+1.8
			do	do	15	80	1144	0	−0.3
			do	do	20	80	1147	0	0
			do	Statistical method	10	78	1100	−2.5	−4.1
			do	do	15	78	1170	−2.5	+2.0
			do	do	20	78	1175	−2.5	+2.4

crop figures calculated using statistical methods. Now, it remains to be seen if sufficient precision is attained by adopting the same sampling scheme *i.e.* dividing the diameters into some convenient arbitrary groups and drawing random samples of representative trees from each group but doing all the calculations by Schwappach's height and form factor curve method. This will afford us an opportunity to compare these figures with the actual ones as well as those obtained from statistical methods.

For this study, the same sample plots as selected in Part I and same factors, *i.e.* mean height and total wood volume are taken. Table (16) contains different sets of results obtained by different methods of selecting sample trees for each of these sample plots. For the sake of comparison the figures, derived from the set of sample trees taken in the usual way are also shown in this table.

A careful study of columns 7-10 will indicate that the figures obtained from the standard method, come closer and closer to the actual figures both as regards to height and volume as the size of the sample is increased to 10, 15, and 20. From this table it is also seen that except for mean height of S.P. No. 27, Lahore Division, the percentage difference based on Schwappach's method for the sample sizes 10, 15, and 20 are below 5%. There are slightly higher differences between the actual and the derived figures from statistical method than those between the actual and the calculated figures from Schwappach's method, using the same samples.

For sample plot No. 8, Montgomery division, all the characters have been worked out separately by the standard method using different sizes and schemes of sampling—Table (17). As all the trees existing in a sample plot are callipered easily and no sampling is done for diameters, we find practically no difference between the actual and estimated diameter and basal area figures. The percentage differences of the stem smallwood and total smallwood are not so high as is the timber percentage difference.

As quite a big number of plots have been clearfelled and information gathered since Champion and Kakazai made an attempt to test the accuracy of the standard Indian sample plot method, the results of such plots are summarised in Table (18) and a comparison made between the crop figures derived with the help of a few selected sample trees and the actual figures obtained by direct measurements after clear-felling. Three factors, mean height, timber volume and total wood volume have been chosen for study and percentage differences calculated on the basis of the actual values (columns 9, 12 and 15).

Taking into consideration all the three characters, from this table, we find that the percentage difference is less than 5 for 15 sample plots out of 37; but considering only the two main characters, *i.e.* mean height and total wood volume, we find the difference less than 5% for as many as 28 sample plots. Besides this, we also observe that it is only S.P. No. 7, Puri division for which the calculated total wood volume differs from the actual by more than 10 %. The high differences can only be ascribed to inadequate and unrepresentative sample trees. This will be quite apparent from S.P. Nos. 18 (ii), 18 (iii) and 18 (iv) which actually contained timber volume but no sample trees of bigger size having timber volume were selected and so we get cent percent difference (colum 12). It is worth noting that in case of S.P. Nos. 44, Insein division, 13,18,19 (i) and 19 (ii) Lahore division and 5, Montgomery division, inspite of selecting about 15 sample trees, the percentage differences did not come down by Schwappach's height and form factor curve method. This all shows that the sample trees selected were not true representatives of the sample plots.

Once again let us refer to Table (16) in which a comparative study of the statistical and the standard methods is made with different sample sizes. From this table we do not find any gain of the former method of calculation over the latter which has rather given better results. It is therefore, immaterial whether the crop figures are computed by the statistical method or by the standard Indian sample plot method, but the selection of the sample trees may always be done by the stratified random sampling design. The sample size may also be increased from about 6 to at least 10.

Table (17): Comparison of actual and estimated crop figures derived from the Standard Indian Sample Plot Method, using different sets of sample trees selected under different sampling schemes, S.P. No. 8, Montgomery Division, Punjab.

Method of selecting sample trees.	Sample Size.	Basal area per acre (Sq. ft.)	Mean diameter (ins.)	Mean height (ft.)	Volume per acre (c.ft.)			Percentage difference calculated on the basis of actual figures					
					Stem timber	Stem small-wood	Total (including branch-wood)	Basal area	Mean diameter	Mean height	Volume per acre		
											Stem timber	Stem small-wood	Total small-wood
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Total sampling	..	54.6	7.0	47	177	883	1146	..	..	..	..	..	..
Sample of choice	12	55.1	7.0	50	200	935	1195	+0.9	0	+6.4	+13.0	+5.9	+4.3
Unrestricted random sampling	6	55.1	7.0	49	145	912	1092	+0.9	0	+4.3	-18.1	+3.3	-4.7
do	10	55.1	7.0	47	152	883	1081	+0.9	0	0	-14.1	0	-5.7
do	15	55.1	7.0	47	192	848	1123	+0.9	0	0	+8.5	—4.0	-2.0
do	20	55.1	7.0	48	179	884	1138	+0.9	0	+2.1	+1.1	+0.1	-0.7
Stratified random sampling	6	55.1	7.0	48	177	938	1185	+0.9	0	+2.1	0	+6.2	+3.4
do	10	55.1	7.0	46	212	845	1138	+0.9	0	—2.1	+19.8	—4.3	-0.7
do	15	55.1	7.0	46	156	885	1118	+0.9	0	—2.1	-11.9	+0.2	-2.4
do	20	55.1	7.0	46	162	865	1099	+0.9	0	—2.1	-8.5	—2.0	-4.1

Table (18): Comparison of crop figures obtained by (i) The height and form factor curve method using a few selected sample trees and (ii) The direct measurements after clear felling.

Species	Division	S. P. No.	Date of clear felling	Age (Yrs.)	No. of sample-trees.	Mean height (ft.)			Timber Volume per acre (c. ft.)			Total wood vol. per acre (c. ft.)		
						I	II	% difference	I	II	% difference	I	II	% diff.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Shorea robusta	Buxa.	1	1927	74	6	81	80	+1.3	2119	2097	+1.0	3746	3586	+4.5
,,	,,	2	1927	93	6	88	86	+2.3	2392	2280	+4.9	2946	3016	—2.3
Tectona grandis	Palamau.	1	1936	37	11	80	79	+1.3	1362	1470	—7.3	1483	1595	—7.0
,,	Insein.	44	1939	49	16	82	80	+2.5	2007	1833	+9.5	2354	2211	+6.5
Pinus longifolia	West Almora.	68	1939	125	6	125	123	+1.6	7272	6983	+4.1	7452	7115	+4.7
T. grandis	Angul.	10	1945	50	8	90	89	+1.1	1973	1964	+0.5	2252	2255	—0.1
Casuarina equisetifolia	Puri.	2	1943	27	8	70	70	0	453	437	+3.7	1107	1059	+4.5
,,	,,	5	1943	27	10	81	78	+3.8	1050	928	+13.1	2087	2062	+1.2
,,	,,	7	1943	26	8	60	57	+5.3	238	187	+27.3	926	822	+12.7
Dalbergia sissoo	Lansdowne.	1	1935	45	6	75	73	+2.7	865	885	—2.3	1500	1455	+3.1
Shorea robusta	Bahraich.	12	1935	103	6	103	103	0	4079	4038	+1.0	4617	4457	+3.6
,,	Ramnagar.	36	1934	102	7	106	106	0	3650	3580	+2.0	3916	3980	—1.6
Morus alba	Lahore.	27	1934	14	6	53	52	+1.9	586	515	+13.8	1664	1565	+6.3
	,,	26	1931	24	31	57	57	0	767	747	+2.7	1884	1835	+2.7
	,,	25	1931	24	14	55	55	0	459	433	+6.0	1714	1633	+5.0

Table (18)—*Contd.*

Species	Division	S.P. No.	Date of clear felling	Age (Yrs.)	No. of sample trees	Mean height (ft.)			Timber Volume per acre (c. ft.)			Total wood volume per acre (c. ft.)		
						I	II	% diff.	I	II	% diff.	I	II	% diff.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Morus alba	Lahore	24	1931	24	20	59	59	0	674	672	+ 0.3	1971	1962	+0.5
D. Sissoo	,,	11	1937	18	14	61	60	+1.7	685	673	+ 1.8	2153	2147	+0.3
,,	,,	12	1937	16	9	50	50	0	153	133	+ 15.0	1246	1168	+6.7
,,	,,	13	1938	18	15	64	64	0	1173	1107	+ 6.0	2483	2458	+1.0
,,	,,	14	1938	16	13	51	51	0	278	251	+ 10.8	1338	1291	+3.6
,,	,,	15	1938	16	14	57	56	+1.8	481	432	+ 11.3	1883	1815	+3.7
,,	,,	16	1938	16	15	55	54	+1.9	506	495	+ 2.2	1529	1512	+1.1
	,,	18	1938	15	16	46	46	0	200	172	+ 16.3	1185	1166	+1.6
	,,	18(i)	1938	15	10	38	36	+5.6	12	12	0	798	795	+0.4
	,,	18(ii)	1938	15	9	39	38	+2.6	0	19	−100.0	825	829	−0.5
	,,	18(iii)	1938	15	11	41	41	0	0	14	−100.0	904	889	+1.7
	,,	18(iv)	1938	15	15	40	40	0	0	21	−100.0	975	977	−0.2
	,,	19 (i)	1940	17	18	44	43	+2.3	72	60	+ 20.0	1425	1351	+5.5
,,	,,	19(ii)	1940	17	16	44	43	+2.3	51	44	+ 15.9	1368	1343	+1.9
,,	Montgomery	1	1938	15	14	55	54	+1.9	419	425	− 1.4	2199	2145	+2.5
,,	,,	2	1938	15	10	46	46	0	160	130	+ 23.1	1571	1518	+3.5
,,	,,	3	1938	15	14	44	43	+2.3	105	85	+ 23.5	1306	1256	+4.0
,,	,,	4	1938	15	15	52	51	+2.0	368	329	+ 11.9	1642	1610	+2.0
,,	,,	5	1938	15	8	46	45	+2.2	129	136	− 5.1	1345	1313	+2.4
,,	,,	6	1934	15	7	44	44	0	146	136	+ 7.4	1348	1248	+8.0
,,	,,	8	1934	15	12	50	47	+6.4	200	177	+ 13.0	1195	1146	+4.3
Populus euphratica	,,	16	1940	31	16	64	64	0	1904	1874	+ 1.6	2392	2449	−2.3

EXTRACTS

RECLAMATION OF DRIFT SANDS.

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By C. G. Laver, Government Forester, Still Bay C. P.

Of recent years, much has been written about erosion and the various ways of combating it, but little is known generally of the equally devastating effect of drifting sands and the means employed to conquer this danger.

Drifting sands occur mainly along the coast, but there are numerous instances where a drift starts inland, due to intensive cultivation of sandy soils, the roaming of stock, excavations, etc.

This article will, however, be confined to the reclamation of coastal drift sands, as inland drifting can also be controlled by one or other of the methods described herein.

Along the sea coast the waves constantly throw up sand, which, after drying, is carried inland by wind. If the supply is not cut off at its scource, these shifting masses of sand proceed inland, usually in the form of dunes, and as they move steadily forward they are replaced by fresh sand thrown up by the sea. It can readily be understood that, in the course of time, vast tracts of land are completely buried by the oncoming sands, turning once fertile soil into desert land.

CONSTRUCTION OF BARRIERS.

The question now arises, how can this invading menace be conquered ? It is apparent that the first step to be taken would be to cut off the supply of sand at its source. This is achieved by erecting a littoral dune along the coast and maintaining it at such a height that no sand can be blown over it. An artificial dune 30 to 40 feet in height would suffice at most places along the coast, but before proceeding to build this the following facts should be borne in mind:—

The angle of repose of dry sand is 30 degrees, which means that, with a dune 40 feet high, the seaward toe will be approximately 70 feet from the line selected for the barrier. Furthermore, storms and strong on-shore winds are liable to drive the water considerably beyond high-water mark, so in order to protect the dune from being undermined, the barrier should be started at least 120 yards from high-water mark.

As a general rule, barriers should be built up at right angles to the direction of the prevailing winds, but with a coast barrier it is advisable to follow the trend of the shore line.

The two practical methods of constructing a barrier are by means of (*a*) brushwood, and (*b*) wooden palings. Where there is ample bush in the vicinity, the former method is the more economical. Wooden barriers have been superseded by the use of Marram grass in parts along the south coast of the Union.

BUSH BARRIERS.

First prepare stakes 5 to 6 feet long by 1 to 3 inches thick, and sharpen at the thick ends. The stakes should then be planted 2 to 3 feet apart and about 18 to 24 inches deep, the simplest method being to lever them into the sand, or, if the sand is sufficiently damp, a crow-bar can be inserted to the desired depth and the stakes thrust into the holes thus made. The stakes are then plaited with brush-wood care being taken to distribute the butts as evenly as possible. In order to ensure against the branches being blown out they should be sufficiently long to rest against three or four of the uprights. Work should be commenced from the bottom and the branches weaved to a height of approximately 3 feet care being taken to leave a few inches of each upright bare, otherwise the top layer is liable to get blown off during stormy weather.

As the sand accumulates against the barrier, any large gaps in the fence should be repaired immediately, so that the sand will bank up as evenly as possible.

Before the barrier is completely burried under the sand, a second barrier is erected immediately above it, as shown in sketch

1 ; this process is repeated until the dune attains a sufficient height.

WOODEN PALISADING.

When brushwood is scarce, wooden palings can be used in creating a dune, but, unlike the brushwood barrier, which when once burried cannot be recovered, the palings can be pulled up when necessary and utilised again.

The handiest size of paling to use is a 6-foot plank, 1 inch thick by 5 to 6 inches wide, and pointed at the lower end.

These are driven into the sand by a heavy wooden mallet to a depth of 2½ to 3 feet, and are spaced 1 inch apart.

Against this fence (Fig. 1) sand is deposited, a certain proportion being forced through the interstices and coming to rest in the comparatively quiet air immediately behind the paling.

As soon as the accumulation of sand approaches the upper ends of the planks, they are pulled up about 3 feet to form a fresh barrier, the operation being continued until the dune has attained a sufficient height.

The easiest method of pulling up the palings is by means of a crow-bar and chain. A light trek chain 4 feet long, the ends of which are joined to a hook, is looped over the head of the paling, and a crow-bar is inserted through the chain. By placing the head of the crow-bar on the top of the nearest paling, two men can exert pressure at the other end of the crow-bar and thus draw the plank up to the desired height. This method is very simple and effective, for no matter how tightly the paling has been embedded in the sand, it can be levered up without much undue exertion.

It is important that the palings be driven into a depth of about 3 feet, as the action of the wind tends to hollow out the sand around the palings in the early stages.

Sketch 2 shows, in various stages how, when viewed from the end, sand accumulates against a line of palings.

FIXING OF DUNES BEHIND THE LITTORAL DUNE.

Having erected a barrier along the coast, the question arises how to deal with the sand that has already been blown up.

In large schemes this may entail dealing with several lines of dunes, in which case the procedure is briefly as follows :—

Firstly, ensure that there be no trespassing over the sand by man or beast, and if this cannot be controlled otherwise, then fencing on the land side will have to be resorted to.

Secondly, proceed by harnessing the lines of dune by means of artificial barriers, beginning with those furthest inland and treating in turn the next consecutive line of dunes until eventually the original littoral dune along the coast is reached. This depends on circumstances. The usual procedure is to work down-wind from the littoral dune.

In general, sand dunes advance in wave formation transversely to the direction of the prevailing winds, with occasional tongues of sand shooting out almost at right angles to the general drift. In other cases, isolated hills are encountered.

If the line of the drift is approximately in the correct position for fixing, harness the sand dune without delay by erecting a barrier along its crest.

Should a portion of the dune not lie on the line decided upon, the barrier at this point could be delayed until the rest of the formation advances into line.

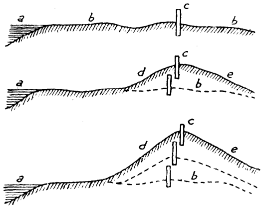
By this method considerable expense is saved, as it does away with having to erect a dune from ground level.

With a view to hastening the action, it may be necessary to erect deflecting barriers in order to direct the oncoming sand to the desired positions.

Deflecting barriers and cross barriers should also be erected when it is desired to fill in any gulchways that may exist in the areas under treatment.

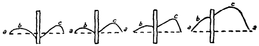
Having fixed the first line of dunes and built them up to a sufficient height, the top should be allowed to round off before the slopes of the dune are planted.

To achieve this, a second barrier (Fig. 2) is erected a few yards behind and parallel to the crest of the dune. It may be necessary at this stage to thin out the laths comprising the original barrier, so as to allow of sufficient



Sketch 1

(a) Sea level
(b) Original sand level
(c) Barrier in three successive stages
(d) Windward slope of dune
(e) Leeward slope of dune



Sketch 2

(a-a) Original sand level
(b) Accumulation of sand on Windward side of barriers
(c) Accumulation of sand on leeward side of barrier

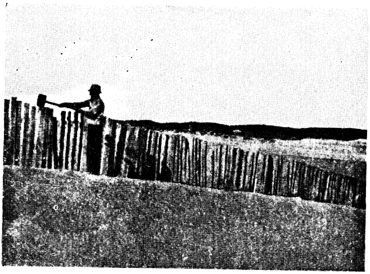


Fig. 1
Wooden Palisading

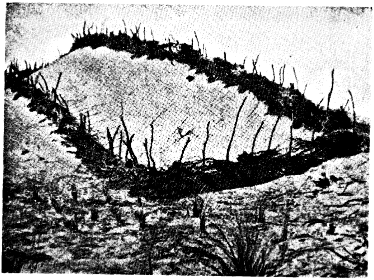


Fig. 2
Double barrier work with Marram grass in foreground

sand being blown through the interstices and being caught up by the second barrier.

Should scouring occur between the parallel barriers, cross barriers should be erected at sufficiently close intervals to stop all movement of sand from side to side. Rounding-off a dune with the object of planting it, can be secured also by planting a belt of Marram grass below the crest on the windward slope, so as to allow the top to blow flat, or by erecting a wooden barrier instead.

GRASS AND TREE PLANTING.

The principle in reclaiming drift sands is firstly to plant the area with grass, and when this has become sufficiently established, to introduce tree or bush growth.

The two main grasses used are Marram grass (*Psamma arenaria*) planted extensively along the coast, and Pypgras (*Ehrharta gigantea*) which can be sown on sand protected from sea-breezes, and also inland.

MARRAM-GRASS PLANTING.

Marram grass can be raised from seed in winter-rainfall areas, but is best propagated by means of setts taken from older clumps. Where it is desired to transport grass for any distance, the tops of the setts should be cut off in order to reduce transpiration and lighten the weight of the bundles.

In stabilizing a dune, begin by planting the windward slope with Marram grass, starting from the top and working downwards, spacing the setts 3 feet apart. In the case of high or steep dunes, planting is usually commenced from the base upwards, so as to allow the top to blow flat.

All the equipment necessary is a planting chain, made of binding wire with links at every 3 feet, and a number of wooden pickets according to the number of men employed. Trained men can pace off the distance with sufficient accuracy without using a chain. The wooden picket should not be too light, otherwise too much energy has to be expended in making the hole. A hardwood pole 4 feet long by 3 to 4 inches in diameter, and sharpened to a long tapering point, is the most serviceable.

The method of planting is shown in Fig. 3.

Care should be taken to plant the setts at least 18 inches deep and to firm them down with the foot, otherwise the plants are liable to blow out during strong wind. Each sett should consist of 3 or 4 individual plants or stems.

Having planted the face of the dune, continue the planting in front of the base to a width of approximately 200 feet ; this will tend to check the force of the oncoming sand, and prevent, to a large extent, scouring at the base of the dune. Where it is observed that the new planting is apt to blow out, bushing should be resorted to in order to hold the sand round the grass. This contingency is likely to occur in gulchways, on steep slopes or on the crest of the dunes.

With the windward side completed, the top of the dune should be planted over, continuing the planting down the face of the leeward side and along the base until the natural vegetation or reclaimed ground is encountered.

Marram grass can be grown successfully on any shifting sands exposed to the sea-breezes where the climate is suitable (Fig. 4) but on sheltered areas, where as a rule it does not grow well, pypgras should be used as the stabilizing agent.

In certain areas, for example, where the slope of the beach is very gradual, it is possible to create a littoral dune merely by planting a strip of Marram grass 100 to 200 feet wide along the coast-line, for, as the sand rises round the grass the stalks grow higher, developing numerous adventitious roots at the joints.

PYPGRAS SOWING.

Pypgras seed may be sown broadcast or in strips, and where desirable it may be mixed with *Acacia cyclopis or Acacia saligna* seed before sowing, the proportion being 6 lb. pypgras seed to 4 lb. wattle seed.

Broadcast sowing. Sow the seed as evenly as possible on top of the sand, and cover with branches. The bush should be broken or lopped to lie flat and when spreading, care must be taken to overlap one branch over the other, pushing the points well into the sand with butts to the prevailing winds. The last row must be firmly pegged down. The reason for this methodical bushing is to minimise the risk of blow-outs during heavy gales.

If the seed is sown during damp weather it will germinate in 2 to 3 weeks, and within the course of a year or two the area will be practically covered over.

Strip sowing.—Lay off strips 18 feet apart, and sow the seed along the strips on top of the sand (Fig. 5). The strips should then be covered with bush pegged down firmly. The strips need not be more than 18 inches wide, as the grass soon throws out stolons, covering the intervening spaces.

As can be readily understood, this method is more economical than broadcast sowing, but it is not recommended for very exposed areas owing to the danger of scouring between the strips. If conditions are at all dangerous or where it is desired to obtain a quick covering, broadcast sowing and bushing should always be resorted to.

As both Marram grass and pypgras lose vigour and tend to die when sand movement around them ceases, it becomes necessary, in order to stabilize the work permanently, to introduce woody plants such as bush or trees, into the grass when or before this stage is reached.

INTRODUCTION OF BUSH AND TREE GROWTH.

In considering which trees to introduce, one may discard most of the timber-producing species, as they are not likely to answer well on newly reclaimed dunes.

Choice is therefore narrowed down to such species as the two wattles, *Acacia cyclopis* (commonly known as Rooikrans) and *Acacia saligna* (Port Jackson Willow), Tuart Gum (*Eucalyptus gomphocephala*), Manatoka (*Myoporum insulare*), Australian myrtle (*Leptospermum*) *laevigatum*), the various indigenous bushes usually found on drift sands, *e.g.* waxberry, blombos, ganna, taaibos (*Rhus crenata*) and various vygies and other Karroo bushes in the dry north.

Both varieties of wattle do excellently on the sand, although the former is more to be recommended, as it branches close to the ground.

Experience has proved that for sowing on sand, best results are obtained if the seed is not soaked. Unsoaked seed germinates only when soil and climatic conditions are favourable, whereas if the seed is soaked, germination may occur before dry weather, with the result that the tender plants are not able to withstand the unnatural conditions forced upon them.

Of the indigenous species, Blombos (*Metalasia muricata*) and waxberry (*Myrica cordifolia*), are particularly useful. Blombos germinates readily from seed, and if given some protection produces bushes from 6 to 12 inches high in one year's time. Waxberry, on the other hand, takes anything from one month to six months to germinate, but one should not be discouraged thereby, as it is an excellent sand reclaimer. It should be sown near the crest of the dunes or where sand accumulates rather quickly, as it responds excellently to fresh accretions of sand.

Seedlings are extremely tender in their early stages, and unless protection is available, very poor results will be obtained. The simplest method is to sow the seed as close up to the Marram grass as possible, on the side affording the most protection, so that the plants are adequately screened until they are strong enough to withstand the cutting effects of the wind and sand. A pinch of seed sown at every alternate clump of grass, should be sufficient to produce an adequate covering of bush on the newly reclaimed areas. Wattle seed sown during the second season, *i.e.* when the grass is a year old, answers well.

GENERAL

The greatest factor in dealing with drifting sand is wind. A single storm may do irreparable harm if vigilance is not maintained and any damage that may occur repaired immediately. It is as well, therefore, to establish at convenient places emergency depots where branches and stakes may be got quickly as occasion demands.

However large or small the scheme, nothing disturbs the work more than being trespassed upon; hence the need for preventing this. When this has been secured and the supply of sand cut off at its source, the sand can be reclaimed as already described.

From the foregoing it might appear that large-scale reclamation work might prove too expensive for the private individual to undertake, but if no attempt is made to combat this growing menace, what of the future?

Fig. 3

Planting of Marram grass

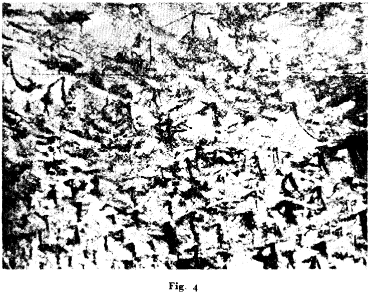


Fig. 4

Marram grass one year old ; not bushing to hold the sand

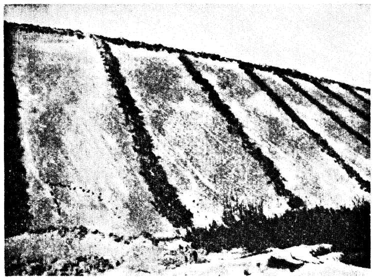


Fig. 5

Strip sowing of pypgrass.

STRANGLED TREES BREED MORE SEED

New technique for higher seed yield.

Tree stranglers are working in western Washington forests to help nature reforest harvested lands.

The timber garroters are Weyerhaeuser Timber Company foresters whose aim is to boost cone and seed output of selected Douglas fir trees. Quantity and quality of this annual crop determines how soon a logged area will bristle with a green carpet of baby fir seedlings. Nature replants over 90 per cent of the forest land in the northwest, and loggers and foresters are anxious to help her.

"The idea came partly from mountain beavers, bears and cats", state Weyerhaeuser's research foresters. "Horticulturists have used the system on orchard trees as early as 1800. So far as is known, it was first tried on forest trees by Swedish foresters in 1938. Our own experiment, started in April of this year, isn't far enough along to report any finding."

"Distress seeding", is supposed to do two things. It stimulates seed and cone production of parent trees specially selected for their form and growth qualities, so that the new tree crop will be of superior quality. Forced seeding also produces more cones on trees in areas poorly stocked with reproduction and thus thickens up the stand.

The theory behind the experiment is simple. A tree pumps up nutrients and water through the centre of its stem and converts them into food, which it sends back down to the tree's living parts through the cambium layer inside the bark. Tree farmers have long observed that physical damage occurring to this inner bark layer, through partial girdling or clawing by bears, mountain beavers or cats, makes the tree think it's dying. Its reaction is a last-gasp effort to procreate its kind by putting stimulated energy into seed production.

Capitalizing on this botanical fact, Weyerhaeuser foresters have tightly strapped about 100 trees with narrow steel bands placed approximately 4½ feet above ground, one band per tree. The "guinea-pig" trees, mostly from 15 to 25 years old, are located on three of the company's tree farms in Washington. Annual diameter expansion of the fast-growing trees will increase the pressure of the bands, causing restriction of food flow and scaring the trees into thinking their days are numbered.

The "strangling" bands will be removed after about two years. The scare effect on the tree's growth mechanism is expected to linger another 5 or 7 years after the liberation. Result: more tree seed spread over acres of forest land.

From "Forest and Outdoors."

BLOOD PLASMA FROM SEAWEED.

Test on new chemical.

The only known sample in the world of a new chemical derived from seaweed, Laminarin, which it is hoped will be a successful substitute for blood plasma and talcum powder, will be shown to the Secretary of State for Scotland, Mr. Hector McNeil, when he opens a new laboratory at the Seaweed Research Institute at Inveresk, near Edinburgh, tomorrow. This use of the new chemical, which is a type of seaweed starch, is now being investigated by scientists in London.

At the institute today it was pointed out that if the new chemical can be used for blood plasma it will considerably reduce demand for blood donors. The potential harvest of dried seaweed from the Scottish coasts next year, it was stated, was about 200,000 tons, capable of producing about 40,000 tons of the new chemical.

The new laboratory is to be named after the the late Professor J. Masson Gullana, a native of Edinburgh and a pioneer in seaweed investigation who until his death in 1947 was Professor of Chemistry at Nottingham.

Prof. T. P. Hilditch of Liverpool University points out that, whereas the seed fats of plants have been studied in enough species to show connection between chemical classification and botanical, and the same is true to a lesser extent of fishes and sea-living animals, there have been only a few such examinations as yet in the case of land-living animals.

The Arctic Health Research Centre of the United States Public Health Service, Point Barrow, Alaska, point out the details of adaptation to cold both by man and animal. This is achieved in both cases either (a) by lowering their heat loss by increasing the insulation,

including reduction in the flow of blood to surface areas and/or (b) by increasing heat production through highest rate of metabolism.

None of the furs were found to be quite as good insulators, under conditions of test, as a layer of medium dense cottons, and above the size of the fox there was no clear correlation between thickness of fur and insulation provided. The polar bear for example, with an extra 10-15 mm thickness of fur, has some 30 per cent less insulation than the white fox.

The relative merits of fat and fur are illustrated in a comparison between polar bear and seal. As an insulator in air, fat is heavy and poor in comparison to fur, but in ice-water the seal loses only 5 per cent of its air insulation, whereas the heat lost through polar bear skin is increased by 20 to 25 times. The polar bear has therefore to compensate this loss by heat production in swimming.

In the case of gulls, which can walk indefinitely on snow at 50 degrees C, measurements were made of the rate of heat loss through the feet of live gulls when placed in iced water. This was so low as to suggest a rate of blood circulation at the rate of only a few cc per hour.

In addition to reduced blood flow to the limbs, the exchange of heat between arteries and veins has been found to be a useful mechanism in human beings promotion of heat economy—arterial blood being thus pre-cooled on its way to the extremities, and venous blood preheated before return to the central circulation. Between the arteries of the upper and lower arm a drop of as much as 10 degrees C differing in different species of animals.

All animals, tropical as well as arctic it is pointed out, are adapted to cold. The distinction is between cold and colder and more often than not, the opposite problem of heat disposal in the tropics seems the more nearly critical. (Schololander et ab 1950, Biological Bulletin, 99, 225, 237 & 259).

The Board of Trade announces that because of the reduction in the export by U. S. A. of Sulphur to U.K. it will be necessary to restrict consumption and that from January 8, 1951, rationing will be introduced.

The Council of National Farmers Union is discussing the possibility of approaching O.E.E.C. to sponsor a demonstration of farm grain conditioning and storage in U.K. next year, as this is felt to be a concern of European agriculture as a whole. In U.K. there are now 13,000 combine harvestors and it may increase to 30,000 in 1955.

(From "*Science Newsletter*" No. 5).

Thinning of Woodlands.

On 11th February, Mr. C.Y. Ross of Dunecht, Aberdeenshire, addressed the members on the subject of Thinning of Woodlands. The Rt. Hon. the Earl of Buckinghamshire was in the chair

Mr. Ross first dealt with the reasons for thinning. They were twofold, namely, to produce the best possible stand of trees and the greatest volume of timber on a given site in a given period of time.

The time of thinning will depend on rate of growth and spacing. The first indication of a need for thinning was the presence of dead, dying and suppressed trees.

Mr. Ross described the thinning grades as laid down by the Forestry Commission. The grade to apply will depend on the rate of growth and the time which has elapsed between thinnings. The aim must always be to maintain a healthy crop and a suitable humus layer. A healthy tree should have one quarter to one third of its length as crown.

The height of the trees will be governed by the site factors. The girth will be governed by the crown size. Each forest site will have a maximum volume provided the canopy is unbroken. The number of stems per acre has no influence on volume as the fewer the stems the larger will be the crowns with a correspondingly larger girth.

As regards the thinning of different species Mr. Ross stipulated that shallow rooted species should be thinned more heavily than deep rooted species to provide more surface rooting area and light demanders more heavily than shade bearers. Exposed boundaries required to be thinned more heavily to enable the remaining trees to become windfirm.

Extraction of thinnings is a costly item. A typical thinning has to have a horse drag to the ride, a tractor and bogey along the ride and a motor lorry for the hard road surface. As the horse hauls a 5 cwt.-load at 1 m.p.h., the tractor a 3-ton load a 5 m.p.h. and a lorry a

6-ton load at 30 m.p.h. the aim should be to have the shortest haulage by the horse. This entails a proper lay out of the forest.

When it comes to treatment of neglected plantations it should be first considered whether there would be any response if a thinning were made. If maximum height has been already reached the crowns will not increase appreciably and therefore it may be more economical to fell. If, however, maximum height growth has not been obtained then by careful handling the plantation can be brought to normality. In every case the policy should be to thin light and often, annually if possible, taking special care with exposed edges.

(From "*Scottish Forestry*, Vol. 4, No. 2).

Red Indians danced for rain and rain came.

Wrecked Redskins wigwams and shattered log cabins litter the reserve of the Stony tribe of Red "Indians" near Calgary which was struck by a freak cyclone a few days ago, four Redskins being killed and seven badly injured.

Last month the Stonys boycotted the famous Calgary Stampede and, led by their medicine-men spitefully performed their tribal rain dance. The subsequent rainstorms washed out the Stampede for the first time in its history. But now, with the cyclone some one seems to have been getting his own back on the Stonys.

(From "*Daily News*", *Mysore*).

The world will have a race of supermen.

Stockholm, August 21, 1950.

Swedish scientists believe that within a few years it will be possible to breed a race of supermen all guaranteed to grow more than ten feet tall. The key to this super race is "Colchicene," a substance derived from the crocus. Successful experiments have already been carried out on rabbits.

Says Dr. Melander of Lund University: "By treating men with a few pennyworth of "Colchicene," there is a theoretical chance of breeding bigger and better humans."

(From "*Daily News*", *Mysore*).

BOOM SPRAY DEVICE IS SUCCESSFUL.

Designer may market invention in Europe.

Handles Corrosive Liquids.

An Australian designer of an apparatus for spraying agricultural crops has been visiting Great Britain and Europe to arrange for the marketing of his device in those countries.

He is Mr. Fred Atherton, Director of A.E. Atherton & Sons Pty. Ltd. of Melbourne, Victoria. The company also manufactures kitchen and hospital sterilizing equipment in its Australian factory, and is an associate of Benham & Sons of Wigmore Street, London.

Mr. Atherton discussed with overseas manufacturers the production, possibly on royalty, of his device which is known as the Athena Boom Spray.

The spray is a low volume pressure unit which has been used successfully in Australia for the protection of linseed crops. It was initially designed to cope with the cutworm pest which had threatened Australian linseed crops with extinction.

Its invention and design by Mr. Atherton solved the problem of the Australian Department of Commerce and Agriculture in the search for a suitable spray unit which would guarantee free delivery of any fungicide, hormone fluid or weedicide without clogging up the jet in the spray cups.

The unit is invariably fitted to a truck but is adaptable to any type of mechanical vehicle. An important component is a conical shaped cup which revolves around a hollow spindle of 5/16 inch bore, with ball bearings in enclosed housing, fitted to reduce friction. The cut is driven by a small 12 volt electric motor drawing 1.74 amps. at full capacity.

The four sprays in the most popular design are mounted on a hollow aluminium alloy boom. The boom is arranged to be carried behind a tractor or truck, with a section slightly less than the width of the truck. This is fitted with the two extended wings on either side.

A 30 ft. coverage is obtained by giving an adequate overlap between each spray. A small gear pump constructed from bronze suitable for handling corrosive liquids is used to deliver the fluid from the main storage tank in the vehicle to each spray head.

Boom for the sprays can be raised or lowered according to the height of the crop.

The apparatus had been found highly successful in Australia and is especially favoured by linseed growers. It can be used for general weed spraying and ensures economic control of weeds in cereal crops, wheat, oats, barley and maize and other crops.

(From "*Austral News*", Vol. 12).

Man-killing oil now protects fruit.

The oil which enemy scientists prepared to spray on and destroy allied armies during World War II is being used in Australia to destroy crop pests, but farmers have been warned that workers should take special care when using sprays and dusts containing the oil.

Known as diethylparanitrophenyl-theophosphate, the oil is the basis of Parathion, E. 605, and other spray materials.

It has been used by entomologists of the New South Wales Department of Agriculture against fruit fly and black beetle and has proved deadly, though lacking the residual effect of B.H.C. and D.D.T.

Entomologists used E.605 in a spray test in New South Wales on a number of China pear trees and although the spray did not prevent flies from stinging the fruit, it did prevent the development of maggots within the fruit.

This was the first time 100 per cent maggot control had ever been claimed. The insecticide was so powerful that it penetrated the skin of the fruit and destroyed the larvae within it.

Some experts have expressed concern at the possibility of injury to the health of consumers of fruit sprayed with this specific but New South Wales entomologists think that since the spray has no lasting effects, fruit which has been sprayed some time before picking should not be dangerous.

However, considerable caution in the use of dusts and sprays based on this oil is recommended.

(From "*Austral News*" Vol 12)

Disease culture may wipe out noxious weed.

New South Wales Department of Agriculture is making available to farmers in districts with an annual rainfall of 25 inches or more a supply of the cultures of the parasitic fungus, *Colletotrichum anthii* which causes a destructive disease in the noxious weed, the Bathurst Burr (*Xanthium spinosum*).

It is proposed that the cultures should be used to establish centres of the disease on burr-infested properties.

The fungus attacks the stem of the plant causing oval-shaped black spots and some of these spots run together to ringbark the plant. The fungus will attack both young and old Bathurst burr plants but will not attack crop or pasture plants and is non-poisonous to stock.

(From "*Austral News*" Vol: 12).

THEY SAY CONSERVATION IS EVERYONE'S BUSINESS

Over one hundred varieties of trees, selected for their use as windbreaks, timber, shelter, shade, or beautification, will be available this year to Shire Councils in the State of Victoria, Australia.

The trees will come from the nursery of the Save the Forests Campaign.

Australia relies to a very large extent on the trees in the catchment areas for the water that means life to its orchards and crops and livestock. It has no snow-capped mountain chains like those giving unlimited water supplies in some other lands.

For more than a century the spread of settlement took a serious toll of Australia's forests. The earlier settlers, concerned with immediate returns, exploited the valuable red gum, montain ash and other resources of timbered country.

To clear land for grazing and cultivation they ring-barked and burned out vast acreages of bush. The process continued over many years with the result that to-day Australia's forests are in urgent need of protection and extension.

For a number of years, Federal and State Governments have been tackling this problem. They are working through Forestry Commissions to remedy the damage of the past. And working with them in several States, are groups of organisations and individuals brought together by their desire to make Australian more "tree-conscious."

HERE LIES A TALE

One of these groups is Victoria's Save the Forest Campaign. Behind its unassuming name lies a story of service to the community.

It began simply enough one night in January 1944, when men and women representing thirty organisations came together in Melbourne to see what they could do to educate others, especially those living on the land, to see the close link between healthy forests and a healthy nation.

They did not propose to cut across the work of Government agencies or to set up a new body with individual membership. Their aim was rather to work through existing organisations. These would support and supplement the Government's tree planting projects.

They adopted the slogan: "Forest, soil and water conservation is everybody's business."

To-day the Save the Forest Campaign has some 300,000 members, represented by over fifty organisations.

One of its first activities was to start a programme of education in fire prevention. Through films, radio, posters and newspaper articles it tells the countryman how to remove fire hazards from his own property, and how he can help in the general work of forests protection.

Another aim of the Campaign was to help country communities to establish their own tree plantations; for there is always a greater interest in tree protection when people own their forests. Since 1944, the Save the Forests Campaign has distributed 200,000 trees for organised community plantings.

EVERYONE TURNS OUT

It is a fine sight to see one of these community tree plantings in progress. The people of the town of Charlton, for instance, have now held two such field days, and they make them festive occasions.

After lunch all the shops and businesses lock up for the afternoon and the local townsfolk and neighbouring farmers foregather in the main street. Housewives, school children, tradesmen, Boy Scouts and Girl Guides, all form groups and set off with pennants flying for the site of their plantation.

This is an area of 27 acres donated by the Charlton Shire Council.

At a given signal from the Master of Ceremonies, everyone goes to work with a will and by the end of the day a potential new forest has been sown.

Incidentally, the Charlton plantings are of particular interest to Victorians, because they have proved that specially-selected trees can be grown without summer watering in areas with less than a twenty-inch rainfall. Already the first trees planted at Charlton in 1947 have grown to an average height of eight feet six inches.

Perhaps the most interesting features of the work of the Campaign has been the setting up of a Research Nursery in the Dandenong Ranges overlooking Melbourne.

It began in 1945 with an experimental planting of 1,000 eucalyptus of eight different species at the home of Mr. C.E. Issac, Member of the Legislative Council. By 1947 more than 25,000 young trees were growning in the nursery, and more land had to be obtained.

TREES ARE READY

To-day, over 100,000 trees in various stages of growth are to be seen there, in trays and tubes, ready to be packed off to any part of Victoria.

Municipal bodies can obtain £15 worth of trees each year from the nursery for payment of £5.

Any landholder in Victoria with more than five acres can use the resources of the movement for the protection and beautification of his property. Payment of a yearly subscription of five shillings entitles him to free trial packets of seed, samples of veneer for tubing of young plants and advice on the raising and growing of trees from seed.

Others who benefit directly from the Campaign's activities are returned servicemen, who in many instances have taken up land in almost treeless country. Any group of Victorian soldier settlers wanting to have their locality declared a demonstration plantation area can get, free of cost, suitable types of trees and expert advice in tree-planting.

These are not the only groups of people benefiting from the activities of the Save the Forests Campaign.

With its counterparts in other States—the Country Womens' Association forestry project in South Australia, and Queensland's Save the Trees Campaign—it is ensuring that tomorrow's Australians will know and value their trees, and so help to preserve and extend one of Australia's greatest national assets—her forests.

(From "*Ausrral News*", Vol. 12)

New machine developed in U.S. helps conserve water in Dry Areas.

A young American farmer has developed a machine to help solve problems of water conservation in dry asreas. The machine, called a rotary subsoiler, punches conical holes into the ground to hold water on the rangeland. The machine, which is equipped with long spikes, leaves holes every 30 inches in rows 36 inches apart. According to its inventor, Paul Walker of Sharon Springs, in the State of Kansas, three units drawn behind a tractor will cover a 27-foot swath.——USIS.

(From *'Agriculture & Animal Husbandry'* U., P. Vol. 1 No. 4).

Radar used to check rain-making trials.

Rain-making experiments in Australia by the Commonwealth Scientific and Industrial Research Organisation include the use of dry ice to "seed" clouds to get them to release their rain. Radar equipment will be used to check each test so that scientists can find out whether they make the rain or whether its occurrence is normal.

For over two years scientists from the Division of Radiophysics, working in Sydney, have been using new radio and electrical methods of explaining how rain forms. Because Sydney's recent abnormally wet seasons has provided little opportunity for artificial rain making, the experimenters have turned their attention to Tasmania. Aim of the new series of experiments will be to produce rain over the hydro-electric catchment areas, forests and agricultural districts, in that order of priority.

Dry ice is still the material used for "seeding" clouds. Silver iodide has given good results in laboratory experiments, but may not be equally consistent in the field.

(From "*Austral News*", Vol. 12, No. 12).

Gearless device made for motors.

An Australian engineer at Hobart, Tasmania, has invented an automatic, transmission unit which will enable motor cars to operate without gears. The unit, which has seven moving parts, gives accelerator control only, thus removing the necessity for clutch and level control. Its location in the vehicle is in the clutch shell. It obviates the necessity for fixed gear ratios, and the drive is governed entirely by the load of the vehicle and gradients.

Tested in an Austin Seven in Hobart, the device was found successful when climbing hills : the ratio of the unit automatically changed to suit the conditions of the road. The inventor asserts that this gives maximum engine economy. He also stated that the life of the moving parts will be longer than those in a gear box, and maintenance will be so simple that amateur mechanics can carry them out.

Full details of the mechanism have not been disclosed, pending application for patent rights.

(From "*Austral News*", Vol. 13).